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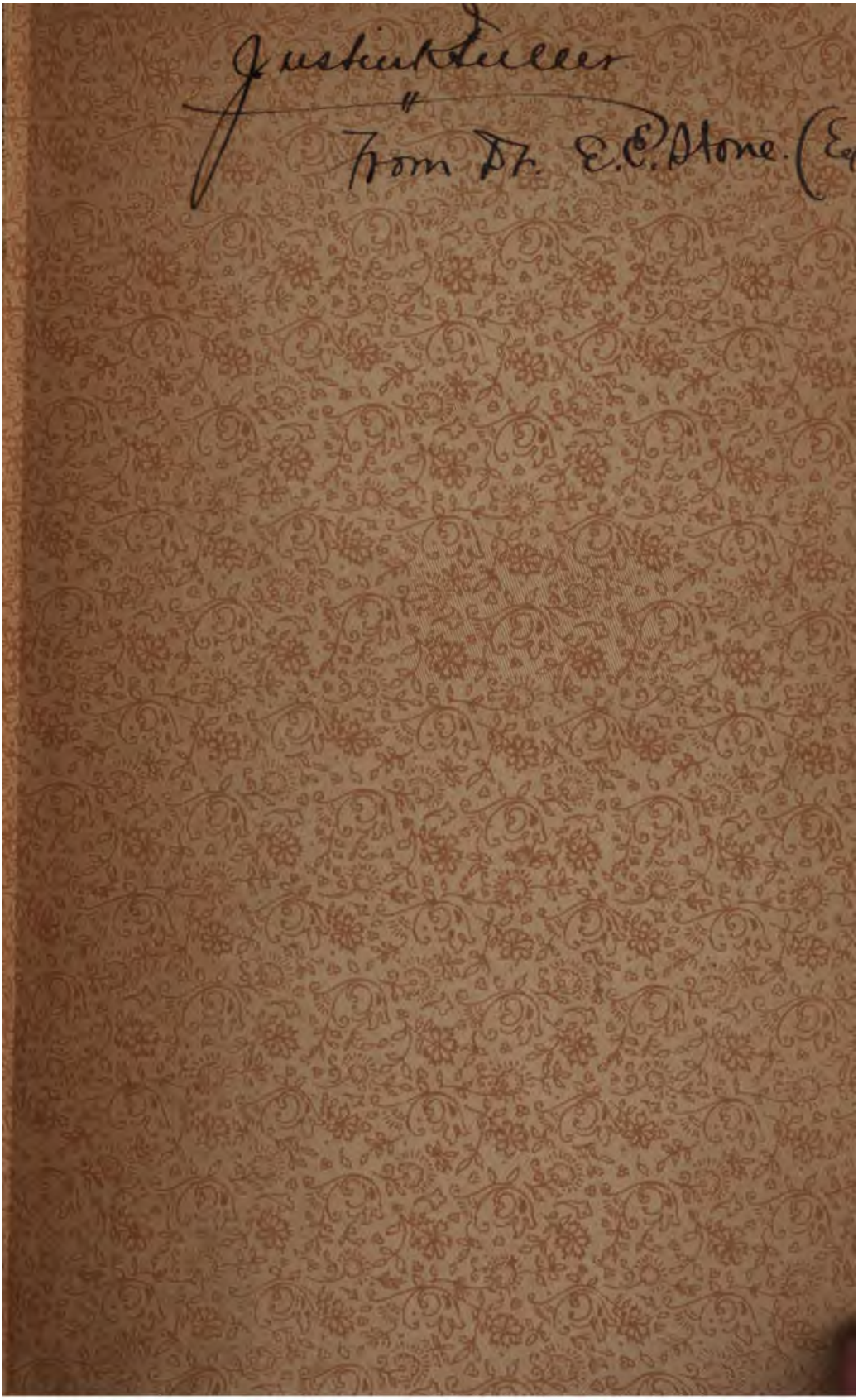
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A TREATISE

ON THE

ACUTE, INFECTIOUS EXANTHEMATA

INCLUDING

VARIOLA, RUBEOLA, SCARLATINA, RUBELLA, VARICELLA, AND VACCINIA, WITH ESPECIAL REFERENCE TO DIAGNOSIS AND TREATMENT

BY

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Illustrated by 12 Colored Plates, 28 Half-tone Plates from Life, and 2 Engravings

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PREFACE.

THE present volume is the outgrowth of a need for such a work felt by the author when young in the practice of medicine. A keen recollection of the difficulties—not to mention the discomfiture—in encountering the acute exanthemata has prompted him during subsequent years of clinical teaching to give special prominence to the differential diagnosis, and, when possible, bedside instruction in this class of affections.

The obstacles in the way of broad clinical study and bedside demonstration in such dangerous and highly communicable diseases as variola, scarlatina, and rubeola render it hazardous and in many instances impracticable to impart sufficient instruction to undergraduates. This fact, together with the limited number of special hospitals and wards for the reception of the acute exanthemata at the disposal of many clinical teachers, makes even graduate instruction in this subject one of the most difficult departments of medicine in which it is possible to obtain a sufficient degree of familiarity.

The truthfulness in detail of photographic reproductions, and the gratifying reception accorded the author's lantern-slide demonstrations of the acute exanthemata, have suggested to him that the time is opportune for a separate work on this most important group of diseases. The work is designed to be practical and to present the subject in the light of modern research. To further enhance its usefulness, and in order to reproduce in color certain negatives requiring special demonstration, the services of Félix Méheux, *dessinateur et photographe* of the Hôpital Saint-Louis, Paris, have been secured, whose life-like illustrations in Chatelain's admirable work on diseases of the skin have sufficiently introduced him to the medical profession. In this way the most delicate shades of color have been given, not only as peculiar to the particular diseases, but, when thought desirable, the various stages through which they pass have been illustrated in color, as well as the conditions most liable to mask their appearance. The illustrations, with the exceptions of Plates I, X, XXIV, XXVII, XXVIII, XXXIII, and XXXIV, are reproduced from photographic negatives taken by the author.

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It has been the endeavor to render the text as complete as is consistent with brevity, and at the same time to give a clear exposition of the subject.

In the chapter devoted to the early history of the exanthemata the author desires to express his appreciation of the kind and painstaking services given him by Dr. Henry E. Handerson, of Cleveland, and of the courtesy extended by the Librarian of the Surgeon-General's Library at Washington for the use of valuable works on the subjects treated of. The author is further indebted to numerous recent writers of this and foreign countries whose works have been freely consulted and to whom he hopes due credit has in every instance been given. For all inadvertent omissions in this direction he asks indulgence.

He further desires to thus publicly acknowledge his obligation for the universal courtesy extended him by his colleagues in calling his attention to unusual and interesting cases, as well as for the permission to photograph such as were required.

In conclusion he wishes to express his appreciation of the assistance given him by Dr. Edward Perkins Carter, Clinical Assistant in Dermatology at the Lakeside Hospital, who has contributed the text for the chapter on scarlet fever and has assisted in the preparation of the index.

553 EUCLID AVENUE, CLEVELAND,
APRIL 15, 1901.

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CHAPTER I.

THE EARLY HISTORY OF THE EXANTHEMATA.

FROM its striking appearance and fatality SMALL-POX was the first of the exanthemata to be recorded. It is of very ancient origin, and comes to us from an uncertain, though remote, past. In the Old Testament there is nothing we can positively identify as the affection unless it be the Egyptian plague (שחון אכעבעת פרח), "Schechin Ababüoth Poreach," which, in the Septuagint translation, is rendered "ἕλχη ρλυχτίδες," and in Luther's translation into German is expressed as *Bösen Schwarzen Blattern* (Exodus ix, 9). Again, it is unfortunate for the medical historian that, among the older writers, pestilence and plague are sometimes used synonymously with small-pox and other eruptive fevers.[1] It is interesting to note, however, that wherever small-pox is mentioned it is never spoken of as a new or unheard-of affection, which leads one to suppose that it is of greater antiquity than the oldest records show.

China.—Some of the most ancient written records are found in China, and to them we naturally turn in seeking the early history of this disease. From the favor shown to medical works in the Royal Edict (246 B.C.)[2]—which consigned to destruction all books save those pertaining to agriculture, law, and physic—we are able to ascertain the *status* of medicine among the Chinese centuries before the advent of European civilization. Thus, from the Jesuit missionaries sent to China, who became familiar with the customs, literature, and—to a certain extent—the diseases of the country, we are enabled, with more or less accuracy, to establish an ancient pedigree for many diseases of the present day. From them we learn that a book, published by the Imperial College of Medicine of Peking for the instruction of the physicians of the Empire, entitled "Tou-tchin-fa," or "A Treatise from the Heart on the Small-pox," states that the disease was unknown in China until some time during the dynasty of Tcheou (which began in

[1] In the first Latin translation of Rhazes small-pox was called *Pestis*, and Constantinus Africanus classed it among the *Pestilential Fevers*. *Vide* Moore (James): "The History of Small-pox" (London, 1815), p. 8.

[2] De Mailla (Jos. A. M.): "Histoire Générale de la Chine" (Paris, 1785), tome i. (Moore.)

1122 B.C.). The name given to the malady in this treatise is *Tai-tou*, which means venom from the mother's breast.

The clinical description of the disease is fairly clear, the symptoms consisting of fever and an eruption of pustules, which increase in size and go through the various stages of suppuration, flattening, and crusting. In the same work inoculation is mentioned as having been practiced during the seven previous centuries, although Chinese tradition has it that it was invented in the dynasty of Song, about 590 years before Christ.[3]

Moore,[4] referring to Father d'Entrecolles, also a Jesuit missionary, as being versed in the literature of this subject, states that small-pox was known in China from the earliest ages. Among other facts he describes a method of communicating the disease, known as "sowing the small-pox," which was occasionally practiced, though generally disapproved of. It was generally performed by planting some of the crusts in the nostril. This is the first account of the inoculation of the disease. It is further stated that the Chinese worshiped a goddess who presided over small-pox. This is a strong confirmation of the antiquity of the malady in China, which some erudite Chinese scholars believe to have prevailed at least 3000 years before the Christian era. Orth,[5] in a recent critical review of this subject, concludes, as a result of other writings and from traditions of the early missionaries, that we are justified in believing small-pox in China to have been originally of a benign type, becoming malignant later on, though this is not made plain in the "Treatise from the Heart," etc.

India.—In Hindoostan, according to the traditions of the Brahmans, small-pox is of remote antiquity. This is confirmed by their sacred books, as well as by the mythology of the Hindoos. Several names are given to it in the ancient Sanskrit language. Sonnerat,[6] a man of letters sent to India by Louis XV of France to collect information concerning the ancient writings of the country, reports that several goddesses worshiped in India were supposed to preside over small-pox, and to determine the fate of those afflicted with the disease.

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[3] "Mémoires concernant l'Histoire, les Sciences, etc., des Chinoises, par les Missionnaires de Pekin," tome iv, p. 392; also, "Lettres Edifiantes et Curieuses par des Missionnaires de la Compagnie de Jesus" (Paris, 1781); tome xviii, p. 351; et tome xxi, p. 11.

[4] Moore, in this chapter, refers to James Moore (*op. cit.*).

[5] Orth (J.): "Bemerkungen ueber das Alter der Pocken-Kentniss in Indien u. China." Janus, 1900, No. viii, pp. 391-396; ix, pp. 452-458.

[6] Sonnerat (M.): "Voyages aux Indes Orientales et à la Chine, par ordre du Roi, depuis 1774 Jusqu'à 1781" (Paris, 1781), tome i, p. 244.

PLATE I.

A Religious Dramatic Representation of the Power of the Hindoo Goddess of the Small-pox. (From an Ancient Oriental Drawing.)

The goddess stands with two uplifted crooked daggers, threatening to strike on the right and left. Before her are a band of the executors of her vengeance. Two of them wear red grinning masks, carry black shields, and brandish naked scimitars. White lines, like rays, issue from the bodies of the others, to indicate infection. On the right there is a group of men with spotted bodies, inflicted with the malady; bells are hung at their cinctures, and a few of them wave in their hands black feathers. They are preceded by musicians with drums, who are supplicating the pity of the furious deity. Behind the goddess, on the right, there advances a bevy of smiling young women, who are carrying gracefully on their heads baskets with thanksgiving offerings, in gratitude for their lives and their beauty having been spared. There is, besides, a little boy with a bell at his girdle, who seems to be conveying something from the right arm of the goddess. This action may possibly be emblematic of inoculation. In a country where every thought, word, and deed are mere repetitions of those of their progenitors, a composition like this bears the stamp of great antiquity. (Moore.)

According to Holwell,[7] an English surgeon who resided many years in Bengal, many forms of worship of Patragali, the small-pox goddess, existed, and sacrifices were offered to propitiate the wrath of the female divinity. An account of this may be found in the "Atharva-Veda," one of their most sacred and ancient books, which, according to the Brahman calculation, was written between two and three thousand years ago. The same writer also mentions inoculation as being practiced in India. It was performed with all the religious rites appointed in the "Atharva-Veda," and delegated to a particular tribe of Brahmans, who were annually, at the approach of spring, sent out from the College of Bindooband to inoculate the people. Orth (*loc. cit.*) has shown that Holwell and Moore were in error in assigning a description of the worship of a definite goddess of small-pox, or even the name of such a goddess to the "Atharva-Veda"; and as a result of the researches of Joly,[8] to whose work he has had access, states that the word *Masurika* (the Sanskrit equivalent for pocken) does not occur in the above work.

According to Joly,[9] the history of small-pox in India can be graphically divided into four periods, as follows:—

In the first epoch small-pox is still unknown as a distinct disease, although it is possible that it existed as one of the countless diseases of the skin, of the ancient Indian medicine.

During the second epoch it is described under the name of *Masurika*, "Linsendisease," as one of the lesser ills, and in the third epoch it is distinguished from the minor ailments, and described as a distinct disease, with even suggestions as to the remedies employed against it.

In the fourth epoch certain other conditions were first recognized as variations of small-pox.

Greece.—When we consider the pathology of the ancient Greeks and their conception of febrile disease in particular, we cannot wonder at their ambiguity in treating of the pestilential or malignant fevers. Local symptoms and eruptions on the skin were subordinate, and considered of little moment excepting as they denoted the progress made on the part of nature in expelling the peccant humors of the disease. Thus, we are not always certain of the exact meaning of such terms as "ἄνθρακες, ἐχθύματα, ἐξανθήματα, ἐρυσίπελας," and cer-

[7] Holwell (J. Z.): "An Account of the Manner of Inoculating for the Small-pox in the East Indies," etc. (London, 1767).

[8] Joly (I.): Professor of Sanskrit at the University in Wurzburg.

[9] Joly (I.): See Orth (*loc. cit.*).

tain other expressions. Especially is it to be remarked that they did not consider the special forms of an eruption of sufficient importance to serve as a basis of classification. Further, when we consider that the great mass of Greek medical literature was destroyed at a very early date, we cannot expect to obtain from their writings any definite information concerning the diseases under consideration. Hippocrates (460-377 B.C.) in his voluminous writings does not give us any definite information concerning the exanthemata. In the third book of "Epidemics" mention is made of certain eruptive diseases occurring during "a pestilential constitution (*κατάστασις λοιμώδης*)," which he speaks of as "*anthrakes*," and other affections called *seps* (*σήψ*) or *septic*; great pustular eruptions (*ἐκθύματα*); "and in many cases great vesicular eruptions (*ἕρπητες*)."[10] In the second book of "Epidemics," which is supposed to have been written by one of his pupils, the following occurs: "Anthrakes appeared at Cranon in a very hot and rainy summer, mostly with a south wind; ichors or humors (*ἰχῶρες*) collected under the skin, and these, being confined, became hot and excited itching; then there arose phlyctænides, or blisters (*φλυκταινίδες*), as if caused by fire, and the patients experienced a burning under the skin."[11] These passages, which possibly refer to small-pox, have given rise to much discussion as to the real meaning Hippocrates intended to convey. Krause[12] claims that the term "anthrakes" refers to small-pox, while Littré[13] is of the opinion that the use of the plural form of this word means that many people were afflicted with a single lesion, rather than that many lesions occurred on the same body: a distinction we will not attempt to follow. At any rate, the description given by Hippocrates in this connection is not sufficiently definite to enable us to affirm that small-pox was known to the ancient Greeks. The term applies to various diseases, and may have included small-pox, as some believe.

Rome.—Among the ancient Romans probably the first description which applies to small-pox was given by Philo, a Jewish author, who lived during the time of the Roman Empire (40 A.D.). In his "Life of Moses"[14] he gives a commentary on the Egyptian plague, to which

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[10] Greenhill (W. A.): "Notes on the Translation of Rhazes on Small-pox and Measles" (London, 1848), p. 146.

[11] *Ibid.*

[12] Krause (C. F. Th.): "Ueber das Alter der Menschenpocken und anderer exanthematischer Krankheiten" (Hanover, 1825).

[13] Littré (M. P. E.): "Œuvres d'Hippocrate complètes," etc. (Paris, 1839-61).

[14] Philo (Jud.): "Vita Mosis," I, C. 22. Ed. Tauchnitz (Bonn, 1838), tome iii, p. 151.

reference has previously been made, in which he says: "There appeared suddenly exanthemata, those afflicted having *phlyktänes* filled with pus, which we may suppose to have been caused by hidden fire. From the great suffering natural to the formation of festers (ἕλκωσις) so extensive, their bodies were tortured and their minds were filled with horror. The lesions thus thrown out soon merged into extensive blisters filled with pus, as if the parts had been burned. It extended over the whole body from the head to the feet." In commenting on this Haeser[15] says: "Although Philo does not say that he had ever observed such a disease, yet it is not to be supposed that the description which fits so aptly to the confluent form of small-pox could be a product of Philo's imagination."

In the reign of Trajan (98-117 A.D.) the works of Herodotus are of the greatest importance. In writing of the fevers which prevailed at the time, "especially the dyscrasic rather than the simple form," he says: "There appeared over the entire body spots similar to flea-bites; while in the malignant and pestilential fevers these eruptions assumed a blister-like character, some becoming like the *anthrakes*."[16] Fearing lest too much importance would be attached to this, he adds: "All, however, are symptoms of a bad blood and of a chymus which eats through the tissue. The eruptions on the face are the most malignant. It is worse to have many than few; the size, moreover, is of importance, for the large are more malignant than the small. Likewise those which soon disappear are more malignant than those which remain a longer time on the surface, and those which smart are worse than those which only itch. Those, however, which break out while the bowels are constipated or when only moderate diarrhœa exists are favorable, but those eruptions are bad which appear with much diarrhœa and vomiting. When, however, with the appearance of the eruption the diarrhœa ceases, it is favorable." Various sequelæ followed the exanthemata, such as malignant fevers, although, for the most part, there remained only an enfeebled condition. Herodotus says further that the anthrax wanders from one people to another, and in most instances is due to certain epidemic influences.

Not only was it observed that the disease was prone to appear on the face, but that its severity depended upon the number of pustules present. Again, as in confluent small-pox, the blending of pustules

[15] Haeser (H.): "Geschichte der Epidemischen Krankheiten" (Jena, 1865), p. 27.

[16] Various terms are used by writers in describing the same disease; thus, herpetic, phlegmonous, erysipelatous, and leprous seem to be used synonymously.

forming large blister-areas is clearly shown in the description here given.

Rome in 166 A.D. was insanitary in the extreme. War, famine, and pestilence followed in quick succession. The returning troops of Lucius Verus and Avidius Cassius had scarcely passed in triumph into the Imperial City when the plague broke out in a most fatal form. During a period of fifteen years there followed a series of distempers variously described and variously named. The main features, according to Galen, were as follow: "Notable was the extensive territory over which the disease spread, from the boundaries of the Persian Empire to the Gallic frontier, and from the Mediterranean to the Rhine. This was attributed to the returning armies and their followers from Syria and intervening countries. The fatality of the disease was so great, especially among the poor, that corpses were carted out of the city in wagon-loads, and a general fear prevailed among the people. At the outset the principal symptoms were foul breath and redness of the mouth. The skin was not hot, but the patient seemed tormented by an internal heat. Oftentimes the oncoming of the distemper might be recognized by these symptoms alone. Diarrhœa was an alarming symptom, which usually appeared from the seventh to the tenth day, and many died at this time. The most conspicuous feature, however, as well as the most constant, was an eruption of the skin. It appeared on the ninth day, which was considered a critical period of the disease.

"The eruption in most instances was pustular, but always dry. The lesions were closely crowded together, covered the whole body, and at the height of the disease presented a blackish appearance (*ἐξανθήματα μέλανατοίς πλείστοις μὲν ἑλχώδη, πᾶσι δὲ ξηρά*). When recovery took place the upper part of the pustules was cast off in the form of a crust, leaving the base of the pustule, and in some instances the normal skin. Healing (*ἐπουλοῦτο*) took place soon after, usually from one to two days. When the lesions contained no pus, the eruption presented a rough or chapped appearance. After the crusts were cast off recovery progressed rapidly."[17] The contagious nature of the disease and the great dread it inspired may be inferred from the words of Ammianus Marcellinus.[18]

[17] See Haeser (*op. cit.*, pp. 30 *et seq.*).

[18] "Et quoniam apud eos (Romanos), ut in capite mundi, morborum acerbitates celsius dominantur, ad quos vel sedandos omnis professio medendi torpescit, excogitatum est adminiculum sospitale, ne quis amicum perferentem similia videat, additumque est cantionibus paucis remedium aliud satis validum, ut famulos percentatum missos, quemadmodum valeant noti hac ægritudine conligati, non ante recipiant domum, quam lavacro purgaverint corpus." Ammianus Marcellinus (ed. Hamburg, 1609), lib. xiv, p. 16.

It seems evident, therefore, that Galen, in common with Sydenham of more recent time, observed a series of epidemics occurring in successive years, varying in malignancy, and from their descriptions it is highly probable that they included small-pox with various other diseases. According to Haeser, there can be no doubt that in the majority of cases in which exanthemata appeared it was small-pox. Further he says: "The conditions which Galen describes apparently relate to SCARLET FEVER, measles, and probably small-pox, as well as dysentery, which is so frequently associated with exanthematous diseases. It is highly probable also that some may refer to *variola sine variolis.*" This view has also been held by Krause. Hecker,[19] on the contrary, while acknowledging a close similarity to the confluent form of small-pox yet rejects it in favor of malignant typhus fever. Later we have in the writings of Eusebius, who lived during the reign of Diocletian and Galerius (302 A.D.), the following: "Although the usual rains had brought the necessary crops, there appeared unexpectedly a famine and plague (*λιμὸς χαι λοιμὸς*), followed by the appearance of another disease (*ἑτέρου τινος νοσήματος*), which may be described as follows: It was a sore or an eruption (*ἕλχος*, which Haeser renders *schwären*, p. 25) which, owing to its burning character, received the name anthrax. It was not only dangerous to life from its wide distribution over the body, but its tendency to attack the eyes caused many men, women, and children to be deprived of their sight." This we recognize as one of the main features of confluent small-pox, and further confirms the opinion that the description applies most accurately to this disease.

Commenting on these writers, Haeser says: "From which it appears, without doubt, that a knowledge of small-pox among the ancient Greeks and Romans probably existed, although one cannot, with absolute certainty, either affirm or deny this assertion."

In 570 A.D. Marius of Avenches, Bishop of Lausanne, describes a violent malady which broke out in Italy and France, characterized by "relaxation of the bowels and *variola.*"[20] This is the first mention of the word variola, and some suppose it to refer to small-pox (Willan,[21] Paulet[22]). Others, with Moore, who quotes extensively from Gregory,

[19] Hecker (J. F. C.): "De Peste Antoniniana commentatio" (Berlin, 1835).

[20] "Hoc anno (570) morbus validus cum profluvio ventris, et variola Italiam Galliamque affixit." "L'Histoire des Gaules," etc., Bouquet. (See Moore, p. 6.)

[21] Willan (Robert): Miscellaneous works, edited by Ashby Smith (London, 1821).

[22] Paulet (Jean-Jacques): "L'Histoire de la Petite Vérole," etc. (Paris, 1768), tome I, Art. 3.

believe that it more accurately describes the bubonic plague. It remained several years, and in 580 ravaged nearly the whole of the Gallic provinces. It was observed by Gregory, Bishop of Tours,[23] who described the disease, as follows: "It was characterized at the beginning by high fever and vomiting, *severe pain in the back* (*renumque nimius dolor*), and a feeling of weight in the head and neck. The vomited matters were either yellow or green in color. Several names were given to it by physicians and ecclesiastics, such as *lues cum vesicis*, also *pusula*, *pustulæ*, and *morbus dysentericus cum pusulis*. The country-folk called the disease *corales*,—*i.e.*, *pustulas*,—because they believed that by appearing on the surface it purified the system. It began in August and afflicted especially infants and young people, although adults were by no means spared. The most conspicuous feature, however, was a painful exanthem, which broke out over the entire body, especially conspicuous on the face, hands, and feet. It consisted of innumerable small pustules, which were of a whitish color and hard to the touch. Much swelling was likewise observed, especially about the eyes; so that temporary blindness frequently ensued. The physicians not only failed to allay the distemper, but what they did seemed to aggravate the disease; hence St. Martin was appealed to, and water from his tomb was sprinkled over the afflicted. Many died during the thickening of the poison (*veneno incrassante*)." This latter applies to the stage of suppuration and crust-formation of small-pox.

Austrigild, wife of Guntram, King of Burgundy, succumbed to the pestilence, and on her death-bed bound her husband by an oath to sacrifice upon her tomb Nicholas and Donatus, the two physicians who had attended her in her illness. Whether the pestilence was one of small-pox or bubonic plague (*morbus inguinarius*), there exists some difference of opinion, for the ecclesiastic mind, although it has given us many valuable data, does not always tend to accuracy in recording medical phenomena. Hecker, however, is of the opinion that the pustular pest of the sixth century undoubtedly refers to small-pox.[24]

Arabia. — The year 569 A.D., according to Gibbon, was an auspicious one for the Mussulman, for it produced Mahomet,[25] the siege of Mecca or Elephant War, and the first appearance of small-pox and

[23] Gregory: "Historia Francorum," ed. Migne (Paris, 1849), lib. v, cap. 35.

[24] Hecker (J. F. C.): "Die Grossen Volkskrankheiten des Mittelalters" (Berlin, 1865), p. 14.

[25] "Is idem annus nascentem vidit Mohammeden. Ex quo efficitur eum annum fuisse annum post Christum natum 572." Reiske (J. J.): "Extractum ex dissertatione inaugurali exhibente miscellaneas aliquot observationes Medicas ex Arabum monumentis" (1746), pp. 9 *et seq.*, in Leiden Library, No. 53.

MEASLES in Arabia. "In this year, at length, the small-pox, the measles, the disease named *nawasal* (scarlatina S. RUBĔOLA, Reiske) and *kynanthropia*, or *al kalab*, first appeared in the land of Arabia. Some of those distempers had occurred before to the Israelites, but never had attacked Arabia until then. In this year also there first appeared certain trees, as the sylvan rue and the colocynth. . . . The Ethiopians, therefore, at this time carried the small-pox into Arabia who in the days of Hippocrates carried the plague into Europe."[26]

According to Moore (*op. cit.*, p. 53), Bruce, of Kinnaird, when at Massuah on the Red Sea, had an opportunity of examining the "Annals of Abyssinia" and other historic works of the country, from which he quotes a manuscript concerning the siege of Mecca by El Hameesy. This author is in accord, for the most part, with the Arabian writers on the War of the Elephant, and particularly the destruction of the Arabian army, which he regarded as a miracle instigated by the devil. He concludes with the statement that at this time the small-pox and the measles broke out in Abrahah.[27]

Ahron of Alexandria, we are informed by Rhazes, wrote a treatise on small-pox and measles during the life of Mahomet, at about the time when the latter was assuming the rôle of prophet. From the extensive quotations taken from this author on small-pox and measles we infer that Ahron was not only held in high esteem in Arabia, but that he was familiar with small-pox and measles three centuries before Rhazes wrote. Ahron, it appears, was the first to write a treatise on these diseases.

During the next thirty years the Arabians invaded Syria, Egypt, and Persia. That the small-pox accompanied the Koran into Europe we are certain, for "three of the early caliphs were pitted with small-pox, and two had white spots on each of their eyes, probably from the same cause, and one fell a victim to the disease."[28]

Mesuë the elder (Masawaih, 857 A.D.), whose work on small-pox is quoted by both Rhazes and Haly Abbas, was chief physician to the Caliph Haroun-al-Raschid.

At the beginning of the eighth century the whole of the eastern

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[26] "Quid sint Nawasel, non invenio notatum in Lexico Gotico. Sed ex vi verbi Nasali concludo exanthematum genus esse, forte apthas, forte etiam, et id potius febrem scarlatinam purpuram aut rubeolos (Germani . . . appellant)." *Ibid.*

[27] "Hast thou not seen how thy Lord dealt with the riders of the Elephants? Did he not make their treacherous design an occasion of drawing them into error; and send against them flocks of birds, which cast down upon them stones of baked clay, and destroyed them like corn trodden down by beasts." The Koran (Sale, trans.).

[28] "Historia Saracen. Elmacin." (See Moore, pp. 64-65.)

and southern coasts of the Mediterranean was subdued by the Saracen arms. In 710 they invaded Gibraltar, and in 731 planted their standards in southern France. No one can doubt that the existence of small-pox and measles, if previously unknown in Spain and France, was now evident. The second writer on small-pox, we are informed by Rhazes, was Bachtishua, physician to Caliph Almansor, who lived toward the end of the eighth century. Measles, he thought, proceeded from blood mixed with a large proportion of bile, and that very gross and moist blood gave rise to small-pox. Isaac, the Israelite, flourished before the beginning of the ninth century, and some have even placed the date of his birth at 683 A.D. Little is known of him, however, except that he was an Arabian writer who is quoted extensively by Rhazes, and that he was familiar with small-pox. From his writings it is evident that he was likewise familiar with Galen's pathology, for he divided small-pox into four varieties, according as it proceeded from blood, phlegm, black or yellow bile.[29]

The first complete description of small-pox, however, was given by Abú Becr Mohammed Ibn Zacaríyá al-Rāzí, called Rhazes, about 910 A.D.[30] It is justly accredited with being the most complete treatise of the time, and still continues to be regarded as a classic production. We have seen that the disease undoubtedly existed in Europe many centuries before the time of Rhazes. Hence it is not surprising that he refers to it, not as a new disease, but as one prevailing in the country. He quotes from the writings of Hippocrates, Galen, Ahron, and others, which implies that the disease existed among the ancient Greeks and Romans.[31] He called it "Dschedrij," or "Jadari" (λοιμικί) [جدرى], while measles was referred to as "Hasbah" [حصبة] (εὐλογία): "You should know that the measles which are of a deep-red and violet color are of a bad and fatal kind, and that the small-pox in which the pustules are yellow, hard, close together, confluent, numerous, and of deep-red or violet color, and that kind which spreads like herpes, and gives the surface of the body the appearance of vibices, are all bad and mortal." Accordingly, measles was regarded as more

[29] "Sed variolæ quatuor modis sunt: aut de puro sanguine, aut plegmatico, aut cholerico, aut melancholico." Latin reduct. Andr. Turrin, Piscien (Lugd, 1516). (*Vide* Moore, p. 121.)

[30] Rhazes: "A Treatise on the Small-pox and Measles," by Abú Becr Mohammed Ibu Zacaríyá Al-Rází (commonly called Rhazes). Translated by Greenhill (London, 1848); Sydenham Society transactions.

[31] According to Channing, it is highly probable that an error was made in the Arabic translation which Rhazes followed; hence his quotations from Hippocrates and Galen are of doubtful value. (*Vide* note D, p. 141 Greenhill's translation.)

dangerous than small-pox, excepting that the latter had a great tendency to cause blindness. The pathology of Galen still obtained, but Rhazes illustrated more forcibly various morbific processes which take place in small-pox and measles by likening them to the changes observed in wine. Thus, "the blood of infants, like the sweet juice of new-pressed grapes, soon begins to work and fret; in youth it is in a state of ebullition and full of spirit; in manhood it becomes strong and settled, and in old age weak and acid." In this way he accounted for the prevalence of small-pox and measles in early life, as well as the immunity conferred by one attack. Although he describes small-pox, measles, and possibly CHICKEN-POX, yet he does not draw a clear distinction between them. He ascribes small-pox to ebullition of the blood, while measles was supposed to arise from vitiated bile. He also speaks of a very mild form, false small-pox, which confers no protection against subsequent infection; occurring during childhood, and which is rendered chicken-pox in Greenhill's translation (pp. 30-37). This appears to be the first mention made of this disease. His treatment was, for the most part, highly rational. Rhazes considered it desirable to limit the number of pustules, for, in a chapter devoted to "The preservation from the small-pox before the appearance of the disease, and the way to hinder the multiplying of pustules after their appearance," he says: "It is necessary that blood should be taken from children, youths, and young men who have never had the small-pox (especially if the state of the air, and the season, and the temperament of the individuals be such as we have mentioned above) before they are seized with the fever, and the symptoms of the small-pox appear in them. A vein may be opened in those who have reached the age of fourteen years, and cupping-glasses must be applied to those who are younger, and their bedrooms should be kept cool.

"Let their food be such as extinguishes heat. Soup of yellow lentils; broth, seasoned with the juice of unripe grapes; kid's-foot jelly; broth made of woodcocks, hens, and pheasants, may be partaken of. Their drink should be water cooled with snow, or pure spring-water, cold, with which their dwellings may also be sprinkled. Let them frequently eat acid pomegranates, and suck the inspissated juices of acid and styptic fruits, as pomegranates, citrons, etc. When the temperament is hot, and there is much inflammation, the patient may take, in the morning, barley-water carefully prepared, to which is added a fourth part of acid pomegranate-juice; but, if the heat be less, barley-gruel and sugar may be given in the morning, and vinegar, lentils, and

especially the juice of unripe grapes may be added to the food; for, by means of these you will be able to thicken and cool the blood so as to prevent the eruption breaking out. This regimen is of great service in all times of pestilence, for it diminishes the malignity of pestilential ulcers and boils, and prevents pleurisies, quinsies, and, in general, all distempers arising from yellow bile and from blood. . . . In the middle of the day let the patient wash himself in cold water, and go into it, and swim about in it. He should abstain from new milk, wine, dates, honey, and, in general, from sweet things and dishes made of a mixture of flesh, onions, oil, butter, and cheese; from lamb, beef, locusts, young birds, high-seasoned things, and hot seeds. When the season is pestilential and malignant, or the temperament is hot and moist and liable to putrefaction, or hot and dry and liable to inflammation, together with this regimen the patient must take some of the remedies which we are about to describe. To those who are of a hot, dry, inflammable temperament give those garden-herbs which are cooling, moist, and extinguish heat, such as purslain, Jew's mallow, strawberry-blite, and also gourds, serpent-cucumbers, cucumbers, and water melons.

"As to melons, especially sweet ones, they are entirely forbidden, and if the patient happen to take any he should drink immediately after it the inspissated juices of some of the acid fruits. He may be allowed soft fish and buttermilk. . . . With respect to those who are fat, fleshy, and of a white-and-red complexion, you may be content to let them eat such foods as we first mentioned, consisting of any cooling and drying things. They should be restricted from labor, bathing, venery, walking, riding, exposure to the sun and dust, drinking of stagnant waters, and eating fruits or herbs that are blasted or moldy. Let their bowels be kept open. . . . Let them abstain from figs and grapes; from the former because they generate pustules and drive the superfluous parts to the surface of the skin, and from the latter because they fill the blood with flatulent spirits, and render it liable to make a hissing noise and to undergo fermentation. If the air be very malignant, putrid, and pestilential, their faces may be bathed with sanders-water and camphor, which (with God's permission) will have a good effect.

"All the pustules that are very large should be pricked, and the fluid that drops from them should be soaked up with a soft, clean rag in which there is nothing that may hurt or excoriate the patient. If the patient's body be excoriated, put under him the fresh leaves of the

lily, and besprinkle him with an aromatic powder, roses, and myrtle; and, if any part be ulcerated, then sprinkle it with the red aromatic powder composed of aloe, frankincense, sarcocol, and dragon's blood."

As a sample of remedial measures the following may be quoted:—

"Take of the best old vinegar, depurated, three pints,
Acid Pomegranate-juice,
Acid juice of Citrons,
Juice of unripe Grapes,
Juice of wart-leaved Rhubarb,
Expressed juice of Syrian white Mulberries,
Infusion of Sumach,
and of Burberries, of each, one pint,
Expressed juice of Lettuce,
Expressed juice of Tarragon, of each, one-quarter of a pint,
Decoction of Jujubes,
Infusion of Lentils, of each, one pint and a half;

Mix them all together, add to them three pounds of sugar, and boil the whole; then take half a pound of tabasheer, and of common camphor, and put them into a clean mortar after they have been well pounded; pour upon them a little of this syrup, hot, and work them quickly with a pestle until they are dissolved; then mix them with the whole and continue stirring it from the beginning to end with a stick of open cane or willow-wood (but cane is preferable), after having thrown in tabasheer and common camphor until they are perfectly united."

He thus alludes to the sequelæ of small-pox: "When toward the end of small-pox there is a great perturbation of the humors, and the patient is seized with a very violent pain in the leg or hand, or any other limb, or the pustules turn to a green or black color, and thereupon he becomes weaker than he was before, and the weakness still increases with the increase of the pain, or the limb is deeply colored; these are signs of death."

Following Rhazes came Avicenna (980-1037 A.D.), who speaks of these affections: "Dschedrij" and "Hasbah"; also of a third form of exanthem "Humak" [حمك], the meaning of which still remains in doubt. Its symptoms, as described, lie between small-pox and measles. It was characterized by miliary pustules and pimples, and is less dangerous than the two other diseases; some think it applies to rubella,[32] others to varicella. On the last hypothesis it is stated by some writers

[32] Haeser (H.), *op. cit.*, p. 64.

that one should wait until the seventh day before making a diagnosis, which renders it highly probable that it refers to chicken-pox.[33]

Avicenna[34] was the first to describe small-pox and measles separately, and to recognize their contagious nature. He coincided with his predecessors that measles was a bilious small-pox, and observed an important symptom, "that in it more tears flow," and that difficulty of breathing was greater than in small-pox. He departed from the treatment of Rhazes, cautioned against cooling the body, and advised sweating to be encouraged by warm coverings. He ordered that on the seventh day the pustules should be opened with a golden needle, for popular opinion ascribed to gold greater healing properties than pertained to other metals.[35]

A change in treatment may already be noted, which reached its height in the sixteenth century, when the cooling measures advocated so strongly by Rhazes were being replaced by the hot or expelling agents against which, later, Sydenham so strenuously fought. Averroës, a Spanish Moor (died 1198 A.D.), was the first to ascribe therapeutic effects to colors. Thus, "white was refrigerant, and red was hot, from the fiery particles with which it manifestly abounded."

Franciscus[36] de Pedemontium, who lived in the vicinity of Naples about 1330, wrote a supplement of Mesuë the elder's compilation of Galen and the Arabian writers, in which small-pox is treated of at length. In the treatment of the disease he remarked that red bed-coverings and warm air tend to expel pustules to the surface; further, he recommended that the blood be carried to the surface by looking on red substances, for, "according to Avicenna, the sight of red bodies moves the blood."

The Arabian writers called attention to the fact that in small-pox the eruption appeared about the mouth, nose, and eyes, and that the lungs were frequently affected. They recognized diarrhœa as a

[33] "Aliquando apparent variolæ similes blactis, et aliquis medicus dixit, quod blactiæ vertantur in variolas. Et inveni, quod est differentia inter has, quia blactiæ sunt rubeæ et apparent in superficie cutis, sicut ignis persicus, et non sunt profundæ eminentiæ nec eminentes." Mesuë, Junior. (*Vide* Moore.)

[34] Avicenna, lib. iv, Fen. i, cap 10. (*Vide* Haeser, *op. cit.*, p. 70.)

[35] "In declinatione vero, ex quo sunt maxime grossæ et magnæ variolæ, debent cum acu de auro rumpi, s. cum dicto acu a duobus lateribus, vel a tribus, vel a quatuor, secundum quod variolæ sunt magnæ quantitatis vel paucæ, perforentur et dimittantur, quod sanies proprie sine aliqua expressione manaverit et exsiccetur suaviter cum cotone sine aliqua violentia et minima expressione." Gentilis de Fulgineo (mor. 1348), *cit.*, p. *Per.* Grüner, p. 28. "Aliquando scinduntur cum forpicibus capita eorum, ne iterum claudantur." Valesc. de Taranta. (*Vide* Grüner: "Fragmenta" [Jena, 1790], p. 48.)

[36] "Supplement Operib.," Joan. Mesuë, Damas.; Francis. de Pedemont., "de Febre Putrid" (Venet, 1602), cap. 6. (*Vide* Moore.)

fatal sign, and a tremulous heart in the eruptive stage as a precursor of death. To favor the eruption when it was delayed beyond the fifth day, hot drinks were given, and some wrapped the body in red cloth, which was supposed to have expelling properties, and medicines of a red color were recommended by Avicenna. Ripe pustules on the face and hands were opened, after which the parts were cleansed with soft cloths so as to prevent deep scarification. The treatment differed but little from that employed to-day, and even a tendency to return to red is being advocated from recent observations as to the chemical effect of certain rays of light.

The writings of the Arabians were copied by the Greeks and Latins. The first conspicuous writer to copy almost *verbatim* the Arabian writings was Constantine the African (1075 A.D.), one of the best-known writers of the school of Salernum, who, in speaking of small-pox, says: "Variolæ arise from the corruption of the putrid blood, and are one of the accidents attending synochus (continued fever). The symptoms of this disease are high fever, headache, ulcers and fullness of the eyes and face, malaise, sore throat, cough, tickling in the nose, sneezing, pricking upon the surface of the body, because the *materies morbi*, seeking exit, pricks the flesh and skin, separating their tissues in its efforts to escape. When you see these symptoms you have certain evidence of the coming of variolæ."[37]

Japan.—When this country was first visited by Europeans both small-pox and measles were found to exist. Kempfer,[38] physician to the Dutch embassy in Japan, 1690, informs us that both small-pox and measles were generally diffused throughout the country at that time. In the archives of the empire it is stated, in the chronicle relating to the principal events during the reign of King Siomu (737 A.D.), that small-pox was very mortal in all parts of the empire.

Great Britain.—It is interesting at this point to note the progress of the disease in Britain. In the library of the Marquis of Buckingham there is an ancient manuscript, written partly in Latin, but principally in the Irish language, denominated the "Annals of Ulster," from which it appears that in the year 679 a grievous leprosy prevailed in Ireland, which was called *Bolgach*, and that the same distemper reappeared in

[37] This is the first time that the term variola was used in connection with a disease that we can positively identify as small-pox. In the employment of the word by Marius, previously noted, we are not certain whether it related to small-pox, to the bubonic plague, or to other eruptions. (*Vide* Constantinus Africanus, "De Morborum Cognitione" [Basel, 1536], lib. viii.)

[38] Kempfer (Engelbert): "History of Japan" (London, 1727).

742.[39] Whether or not this refers to small-pox we do not know, excepting that in Brian's Irish dictionary the word "bolgach" is translated the small-pox, and the plural, "bolgaidhe," blisters. This, it may be mentioned, was thirty years before the invasion of Spain by the Moors. It may also be remarked that at this time several celebrated schools and academies flourished in Ireland, which were crowded with foreign scholars. Many saints and other missionaries flocked here from the continent of Europe to receive instruction, which may explain the early appearance in Ireland of what some suppose to be small-pox. This seems confirmed by Irish chronicles of the fourteenth century, when small-pox (*gala breac*; *i.e.*, the speckled disease) was generally diffused, in which it is recorded that in the year 907 Princess Elfreda, daughter of Alfred the Great, "was sick of the small-pox, and recovered."

The next case occurred in a grandson of the same Elfreda, whose death is recorded in the Bertinian Chronicle as follows: "About Christmas 961 Baldwin, the son of Arnolph, Earl of Flanders, was attacked with a disease which physicians called variola, or the pock, and died on the day of our Lord's circumcision following."[40] In the genealogy of the Earls of Flanders, preserved in the Cistercian monastery and published by Bouquet,[41] it is further recorded that Arnolph the Great begot Baldwin, who died of the variolous disease, and was buried in St. Bertin. According to Moore, this is the first authentic mention of the words variola and pocca in the same passage. No definite name apparently existed at this time, either in Greek or Latin, for small-pox and measles. *Pestis*, *pestilentia*, and *lues* were applied to these in common with other epidemics. *Pestilentia ignis*, the fire-plague, was not only applied to erysipelas, but to all dangerous eruptive disorders. It is supposed that at this time the word variola was formed. It is derived either from the Greek word αἰολος (*varius*, *variegatus*), *i.e.*, spotted; or from the Latin *varus*, as employed by Celsus and Pliny to designate a pimple; from which the Spaniards derived their name *viruelas*, which the Italians liquefied into *il vajuolo* and from which the French framed their *vérole*. The French had also a name in common use for small-pox: *piquote* or *picote*, which may be found in the writings of Rabelais and other old French authors. It appears that, when the malady extended to the north of Europe, the Saxons, instead of adopt-

[39] O'Conor (C.), Esq.: "Dissertations on the History of Ireland" (Dublin, 1766).
[40] Bouquet: "Historiens des Francs et des Gauls" (Paris, 1738), tome ix, p. 79.
[41] *Ibid.*, tome xiii, p. 417.

ing the more classic word variola, adhered to or invented the vernacular name *poccadl*, signifying a pock, or pouch. The Anglo-Saxons adopted this word, which was variously spelled by different writers,—papulo, pockcha, pocca, pocc,—until it finally became pock and pox. The term morbilli, measles, from *morbillo,—i.e.*, the little disease,—was first used in Italy to distinguish it from the great disease or plague, which was known as *il morbo*. When syphilis appeared in western Europe it was also called "the pox" or the "great pox." Hence it became necessary to prefix a qualifying term to variola, from which we have the English *small*-pox and the French *petite vérole* now in use.

Another case of small-pox is recorded in the convent of St. Gall at about the same period. It is stated that St. Gall, a venerable monk, having been fully enlightened in the learned academies of Ireland and believing his countrymen no longer needed his pastoral care, resolved to set out on a pilgrimage to convert the less-civilized people of Switzerland. Finally a convent was founded which bore his name, in the annals of which the following is recorded: "Notkarus, who died in the year of our Lord 966, was both monk and physician, being consulted by Henry II of Bavaria, who was duly restored to health. He was sent for by the bishop of the diocese who had been suddenly taken ill. Notkarus, knowing the plethoric regimen to which the good prelate had been accustomed, bled him most copiously. After observing the rich, inflamed blood of his patient he prognosticated that in three days his reverence would break out with the small-pox. The bishop, although fully prepared, was greatly alarmed, and besought Notkarus to stop the dangerous eruption. Notkarus replied that, though it were easily done, it could not be entertained, as such a procedure would inevitably result in death. The disease was therefore allowed to run its course, and happily with a favorable result."[42]

In the Harleian collection in the British Museum there is a very ancient Anglo-Saxon manuscript which is supposed to have been written in the tenth century. It is written in Saxon and Latin, and contains many pious exhortations, exorcisms, and prayers. One of them is as follows: "In the name of the Father, of the Son, and of the Holy Ghost, Amen. N° May our Saviour help us. N° O Lord of Heaven! . . . hear the prayers of thy man-servants, and of thy maid-servants; O Lord Jesus Christ, I beseech thousands of angels that

[42] **Ekkard (Junior): "Liber de Casibus Monast. Sti. Galli," etc. (Francofurtum, 1661), p. 52.**

they may save and defend me from the fire and power of the small-pox; N° and protect me from the danger of death; O Christ Jesus! incline your ears to us," etc.[43] This affecting prayer shows strongly the terror which the small-pox inspired at that time.

There is a similar monastic manuscript in the Cottonean Library containing extracts from the writings of Cassiodorus and other primitive fathers of the church. In this collection there is a prayer to St. Nicaise intended for the consecration of charms made by nuns and inscribed with the saint's name, to be worn as a protection against small-pox. This copy, according to Moore, was probably written in the tenth century, as it is followed by a calendar of the paschal terms beginning with the year 988, and continued by successive hands to the year 1268.

"In the name of our Lord Jesus Christ, may the Lord protect these persons, and may the work of these virgins ward off the small-pox. Saint Nicaise had the small-pox, and he asked the Lord (to preserve) whoever carried his name inscribed.

"O Saint Nicaise! thou illustrious bishop and martyr, pray for me, a sinner, and defend me, by thy intercession, from this disease. Amen."[44]

It is of interest to note the views entertained as to the nature and management of the exanthemata during the thirteenth and fourteenth centuries. It may be remarked that variola, morbilli, rubella, and varicella were all regarded as modifications or varieties of the same disease. Michael Scott (1250 A.D.) gives substantially the same pathology and treatment as given by Constantinus Africanus and the Arabian school. Gilbert (Gilbertus Anglicus, 1275) in his "Compendium of Medicine," the oldest English medical work extant, mentions that in small-pox the patients should be attentively guarded from cold; neither should they have cooling medicines, or a cooling diet. He likewise advises the opening of the pustules with a golden needle, and says that "the *vetulæ provinciales*"—*i.e.*, the old women of country districts—"recommend that the drink of the sick should be some burnt purple or red ingredients, which, like cloth dyed in grain, have a secret virtue in curing the small-pox."

Bernard Gordon (1305 A.D.), a Scotch physician, professor in the University of Montpellier, in his "Lilium Medicinæ" says:—

"Variolæ and morbilli are certain abscesses or small pustules ap-

[43] The mark N° denotes when the exorcist made the sign of the cross.

[44] Biblioth. Cotton. Caligula A. XV. No. 30, p. 125. (*Vide* Moore.)

pearing upon almost the whole of the body. They belong to the class of infectious diseases and originate from corruption of the blood and humors; variola rather from the blood and morbillus from the bile. This disease is produced by retention of the menstrual blood in the pores of the fœtal membrane, and as nature becomes stronger she expels it from, and cleanses the body, either in infancy, childhood, or adolescence, rarely in youth, and rarest of all in old age. The same method of evacuation, however, is common to all.

"Exceptionally, too, the disease arises from other causes,—*e.g.*, if one is begotten during the menstrual epoch; and this mode of origin is very bad, because persons so generated rarely escape lepræ or some other terrible sickness. It is also due to bad regimen, and especially to the use of easily and quickly decomposing foods, like milk and fish at the same meal, and particularly to warm and moist foods and in those who neglect phlebotomy. Fourthly, the disease is generated in corrupt and pestilential seasons. Fifthly, it is prone to follow imperfect crises in sanguineous fevers. There are thus five possible causes, four of which are of this species; since some cases arise from the blood, some from the bile, some from black bile, and some from phlegm.

"There are certain symptoms which foretell the approach of variolæ: *e.g.*, itching of the nose, sparks before the eyes, frightful dreams, redness of the face, breaking over the whole body, and when the pustules begin to appear they look like grains of millet or ant-heads. Then they begin to multiply and enlarge, next form sanious crusts, and finally dry up and fall off."

In the treatment he recommends phlebotomy (in the median vein or from the bridge of the nose) in robust and phlethoric patients, the avoidance of remedies adapted to drive in the eruption, and cautions against the use of inunctions of oil, cold applications, and cold air and water. On the other hand, he recommends acid drinks, such as the juice of sorrel, pomegranate, sour grapes, lemons, and acid fruits, with coriander, water-lily (nenuphar), camphor, etc. Laxatives are to be avoided, since the disease is prone to occasion diarrhœa. Then the entire body should be wrapped in red cloth. For protecting the eyes he recommends a collyrium of coriander, sumach, rose-water, and white of eggs, instilled frequently into the eyes. The pitting of the skin is to be treated with an ointment of litharge, subcarbonate of lead, burnt starch, powdered millet-seeds, oil of lilies, and wax.

John of Gaddesden, professor in Merton College, Oxford, Ordinary

Physician to King Edward I of England, in his "Rosa Anglica" (1305) devotes much space to a description of variola. He says: "Variolæ take their name from the fact that they affect the skin variously (varie), infecting and occupying it in different parts with abscesses. They are caused by corruption of the blood, and in this is their point of distinction from morbilli and punctilli. Morbilli are small abscesses in the skin generated by bile. The diminution of apostemative diseases, because by reason of the sharpness of bilious matter they occupy less space, yet those are, in fact, variolæ of bilious matter and appearing in very minute pustules. Punctilli, however, are infectious, commonly sanguineous, as if produced by the bite of a flea, but lasting for some time. Punctilli, too, are of two kinds: large and small. Of the latter I had already spoken. The large infractions are broad, red, and dusky. The same description will apply to morbilli, except that they are smaller and arise from bile.

"Both variolæ and morbilli arise from the retention of menstrual blood in the fœtus, and accordingly Averroës says that no one can escape the variolæ. They may also be produced by the use of food or drinks prone to putrefaction, such as the blood and juices of animals; from the mixture of watery and warm articles of food,—*e.g.*, wine and milk, fruit and ginger, fish and garlic or onions,—which produces fermentation. The ingestion of much wine or new beer in persons who neglect phlebotomy may also occasion the disease. It occasionally happens, too, that a man suffers the disease twice, because in the first attack the *materies morbi* was not all expelled. A pestilential quality of the air may also produce variola. Persons of a warm and moist complexion are more prone to the disease than those of a dry complexion; infancy, childhood, and adolescence more than manhood and old age. It occurs oftener in spring than in winter, and frequently in autumn when preceded by a warm and dry summer.

"Variolæ do not occur in the fœtus *in utero* because, first, the heat here is moderated and thus does not produce ebullition; second, the force of nature is employed in another direction,—the formation of tissues; third, because there is a lack of emunctories; and, fourth, because that menstrual blood is preserved by the heat of the womb from both ebullition and corruption.

"It is also to be remarked that it is not necessary for everyone to have the variolæ, though Isaac in his fifth book on fevers says that it is. This statement, however, should be understood to mean that every one inherits a predisposition to the disease from the menstrual blood

remaining in the infant after birth. Now, unless this is expelled by the urine, the fæces, the perspiration, or by phlebotomy, the man will actually suffer the disease. Unless, indeed, it so happens that he was conceived in a perfectly clean and healthy woman, after the menstrual flow, and begotten by a father sound and of good regimen; that the child possesses a good complexion, is temperate, not gluttonous or irregular in living, which is rarely the case.

"The premonitory symptoms in variolæ in the sanguineous form are pain in the head and back due to the distension of the dorsal vein by the excess of corrupt blood. In variolæ there are redness and swelling of the face, disturbances of the eyes, and lacrymation; but in morbilli the lacrymation is more marked and the pain in the back less, because in the latter disease the symptoms are due to the excessive virulence of a small quantity of corrupted blood, while in variolæ there is great distension of the narrow dorsal vein. . . .

"Diarrhœa, bloody urine, dyspnœa, syncope, are all of bad omen. If the eyes are affected, blindness or opacities of the cornea are frequently left behind.

"Variolæ depart gradually, morbilli abruptly."

The treatment recommended was venesection and mild purgation, acidulous drinks; protection of the eyes, respiratory organs, nares, mouth, and intestines; promotion of desiccation after maturation of the pustules, and prevention of disfigurement.

"Then a scarlet-red cloth should be taken and the patient rolled up completely in it or in some other red stuff, as I did in the case of the son of his majesty, the King of England (Edward I), when he suffered from this disease, and I had everything about his bed made red. And this cure was a good one, and I cured him without leaving any traces of variolæ." This treatment, which has received such wide recognition, seems to have almost attained perfection in Japan, where it is related by Kempfer (*op. cit.*) that, the emperor's children being stricken with variola, it was commanded that not only the hangings and bed-coverings be of a red color, but persons entering the royal chamber be clad in scarlet gowns.

Thus the Arabians, copied by the Latins, continued, although modified by deteriorating influences, to be the standard authorities on the exanthemata until the age of the *renaissance* in the fifteenth and sixteenth centuries.

America.—From manuscripts at our disposal it is evident that both small-pox and measles were carried to the Island of St. Domingo

in the year 1517.[45] The effect of the small-pox among a new people may be inferred from the fact that of the Indians in Hispaniola numbering several millions, the majority were either totally extinguished by labor, famine, or by the small-pox and measles. When Cortes sailed from Cuba in the year 1518 for Mexico it is said that an infected negro slave covered with pustules, landed with the troops of Zempoalla, from whom the natives soon caught the infection, which spread through Mexico. It is estimated that three millions and a half of people were destroyed from this source, among the victims being the Emperor Quetlavaca, brother and successor to Montezuma. The disease soon spread to Caracas and wrought such havoc among the Indians that they fled in terror to the most distant parts, hoping to escape the horrible malady imported by the whites, but only the more rapidly to spread the infection. Handerson[46] quotes Toner to the effect that small-pox prevailed among the Indians of New England as early as 1618, and its ravages were felt among the white settlers of this section in 1622 and 1638.

At this time the spirit of adventure was strong, and various parts of the world were visited and explored. In 1707 an epidemic of small-pox broke out in Iceland, destroying 16,000 persons, or over a fourth of the inhabitants of the island.[47] Greenland next succumbed to small-pox in 1733,[48] and it is stated that it spread so rapidly and was so fatal that fears were entertained lest it depopulate the country.

Like the other exanthemata, we have seen that SCARLET FEVER is of uncertain origin (see page 7). There can be no doubt, however, that it existed under various names long before it became recognized as a special disease. Possibly the fire-plague previously mentioned refers to it, and, as will appear, it was at first confounded with erysipelas. It is highly probable, also, that the disease prevailed in Arabia, and is referred to in the following from Haly Abbas, translated by Constantinus Africanus:—

"In this affection when it reaches maturity the lesions upon the body neither discharge of their own accord nor when punctured. The eruption is of a reddish color, and consists of millet-seed-sized papules, which appear, for the most part, on the face, although it extends over the whole body. Further, there is commonly swelling and redness of

[45] Robertson: "History of America," vol. i, p. 260.

[46] Handerson (H. E.): "Baas's History of Medicine" (New York, 1889), p. 241.

[47] McKenzie (Sir George Stewart): "Travels in the Island of Iceland" (London, 1810).

[48] Crantz: "History of Greenland," vol. i, p. 336.

the face and extremities, itching of the temples and ears, inflammation of the nose, difficulty of swallowing, and a feeling of heaviness in the head."[49]

It was not until the middle of the sixteenth century, however, that scarlet fever was positively recognized and accurately described. Ingrassias, of Palermo (1510-1580), observed an epidemic at Naples which he differentiated from measles and to which he gave the name *rossalia* or *rossania*.[50] He emphasized the fact that it attacked children before puberty and that it seldom recurred in the same individual; that the disease was limited to the epidermis, was of a reddish color, invaded the whole surface, and was accompanied by a fever. It is thought by some that the affection was also observed in France by Coyttar,[51] of Poitiers, in 1578.

Later, according to Noirot,[52] Baillou described an epidemic occurring in Paris in 1574 which he called *rubiolæ* and distinguished from morbilli (measles). He further observed that it appeared like erysipelas, while variola and morbilli more closely resembled miliary herpes. This description, however, is not complete, and we are left in doubt whether or not scarlet fever was recognized in Paris at that early date.

Soon after this an epidemic of like character, supposed to have come from Asia, appeared in the south of Europe and was first observed in Spain, where it was spoken of by Mercado,[53] of Toledo, physician to King Philip II, as follows: "Although it is commonly called erysipelas, yet it differs from the true erysipelas of the ancients." In another place he says: "The patient was suddenly seized with fever, headache, and retching. An intense redness appeared on the face and in the throat. The rash extended upward to the eyes, was symmetrical in distribution, and the skin was slightly swollen. Soon after the fever increased and the eruption extended to the neck and upper part of the trunk. In our suffering patient the blush was not that of erysipelas."

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[49] Theor., lib. viii, cap. 14.

[50] "Nonnulli morbillos et rosaliam eundem esse morbum existimarunt; nos ipsi nostrismet oculis diversos eorum affectos esse videmus; morbilli enim racematim venire solent. . . . Etsi nonnulla scarlatinæ symptomata desiderantur, tamen accurata exanthematis descriptio, et cum morbillis et variolis comparatio, hunc morbum subintelligendum esse verisimile reddit." Ingrassias (Joh. Philipp): "De Tumoribus præter naturam," etc. (Neapoli, 1553), cap. i, p. 194. And more fully in "Informatione del pestiforo, et contagioso morbo" (Palermo, 1576).

[51] Coyttarus (Joan.): "De Febre purpurâ epidemiali et contagiosâ" (Parisiis, 1578), libri duo.

[52] Noirot (M. L.): "Histoire de la Scarlatine" (Paris, 1847).

[53] Mercado (L.): "De Essentiâ, Causis, Signis, et Curatione febris malignæ, in quâ Maculæ rubentes similes morsibus pulicum per cutum erumpunt" (Basel, 1584).

Other Spanish writers likewise mention the disease under the name *garrotillo.*

Early in the seventeenth century the disease appeared in various parts of Europe. From 1610 to 1620 severe epidemics broke out in Naples, Rome, Malta, and Sicily. It was regarded as a new affection, and many names were applied to it, such as *ulcera anginosa, angina, purpurum, ignis sacer.* Among other writers it was studied by Nola, of Naples,[54] who observed the following symptoms: Redness of the pharynx, tongue, and tonsils, with a feeling of constriction in these parts, difficulty of swallowing and respiration, offensive breath, and a bad taste in the mouth. This was accompanied by an erysipelatous inflammation of the pharynx and the whole buccal cavity, together with redness of the face and neck, and violent fever. On the second day the swelling of the neck was often well marked, and a livid tint to the mucous surfaces was observed. Sometimes crusts formed in the nares, and small excoriations in the mouth were seen. Death often took place on the fifth or sixth day, although a fatal termination was not infrequent on the first day of the disease. Its contagious nature was recognized, and it was remarked that it appeared without prodromata. It prevailed especially among children, although in some instances adults were likewise attacked. It was thought to be more severe in girls than in boys. In commenting on this, Bretonneau[55] says: "The diffuse efflorescence of scarlatina is clearly indicated in many passages where, according to the usual expression of the time, it is termed erysipelas."

At this time scarlet fever appeared in Saxony, and was observed in Poland by Döring,[56] of Breslau, in 1610. Although the disease had been previously described, it was not possible to form any definite opinion as to its nature until Sennert's[57] clear description appeared in 1619. He studied the affection in an epidemic at Wittenberg, and differentiated it from small-pox and measles. He says: "Besides these differences, there is another which, though rare, I have often observed. I have hitherto been doubtful under what name I might distinguish it from other diseases, for, although, like erysipelas, it seizes upon the entire surface of the body, yet I have not seen it attack adults,—which often happens in erysipelas,—but prevails only among infants. I pre-

[54] Nola (Franc.): "De epidemicâ phlegmone anginosâ, grassante Neapoli" (Venet., 1610), 4.

[55] Bretonneau (Pierre): "Des Inflammations spéciales du tissu muqueux, et en particulier de la diphthérite" (Paris, 1826), p. 74.

[56] Quoted by both Sennert and Most.

[57] Sennert (David): "Opera Omnia" (Lugduni, 1676), vol. vi.

fer, therefore, to refer it to morbilli, and perhaps it is the disease which Forestus calls *purpuram et rubores* (ερυθηματα). Ingrassias writes that it is called by the Neapolitans *rossaniam* and *rossalia*. The eruption consists of reddish maculæ, or, as it were, little erysipelatous spots, accompanied by a slight degree of swelling over the whole body. During the height of the disease, on the fourth or fifth day, the entire surface of the body appears red, giving the appearance of a burn (*quasi ignitum apparet*), as if the patient were laboring under universal erysipelas. In the decline of the disease the redness diminishes, and large, reddish spots, as in the beginning, appear, which disappear finally on the seventh or ninth day, with scale-like desquamation of epidermis. This disease is grave and often fatal, for the redness is very marked. The thirst is inextinguishable, and frequently inflammation of the lungs (giving rise to cough) appears, with inflammation of the fauces and other viscera. Delirium and other threatening symptoms are often present. At length, during the decline of the disease the *materies morbi* is transferred to the joints of the extremities and excites pain and redness as in rheumatism. The skin is shed in scales. Soon after the feet swell, even to the heels and soles. Marked disturbance is likewise observed in the hypochondriac region. Respiration becomes more difficult, and at length the abdomen swells and the sick are not restored to their former health without much labor and after a long time; often they may die." According to Most,[58] the disease was also observed in Schlesien by Winsler, of Brieg, in 1642, and by Fehr in Saxony in 1652, from which time it seems to have been lost sight of in Germany for half a century.

The common name, according to Storch,[58] was *rothen hund*,—*i.e.*, red dog,—from which the Hollanders derived their *roothont*. It may be that *rötheln* is a corruption of the same word, although of this I have been unable to find any mention; more probably it is derived from *roth*, red, and used in a diminutive sense (*rötheln*: reddish, pink).

At this time scarlet fever seems to have first appeared in England and later in Scotland.[59] Severe epidemics occurred in London between 1661 and 1675, and it was described by Sydenham,[60] who called it *scar-*

[58] Most (George Frieder): "Versuch einer Kritischen Bearbeitung der Geschicte des Scharlach fiebers und Seiner Epidemien von den ältesten bis auf unsere Zeiten" (Leipzig, 1826).

[58] Storch (F.): "Praktischer und Theoretischer Tractat vom Scharlach-Fieber," etc. (Gotha, 1742), p. 178.

[59] Sibbald (Robert): "Scotia Illustrata" (Edinburgh, 1694). Part I, p. 55.

[60] Sydenham (Thomas): "Opera universa" (Londini, 1685). English translation by Greenhill, Sydenham Society, London, 1844.

latina, which name it still bears. That Sydenham was a century in advance of his contemporaries is evident from the fact that Withering,[61] in 1792, was accredited with having differentiated between scarlatina and measles.

Chicken-pox, naturally, from its mild nature attracted little attention, and aside from the writings of Ingrassias (*loc. cit.*) and Guito Guidi[62] (Vidus Vidius, 1585) in Italy, which clearly refer to it under the name *crystalli* (crystals), it was confounded with mild forms of variola.

From this we may conclude that small-pox and possibly measles prevailed in China and Hindoostan from remote antiquity, but did not extend through the western nations until a later period. We have no positive proof that they existed among western nations until about the fifth or sixth centuries. It is supposed by some that they reached the eastern coast of Arabia by trading-vessels from India, for we first read of an epidemic near Mecca, during the War of the Elephant in the year 569, immediately before the birth of Mahomet. During the latter part of the sixth and the whole of the seventh centuries the disease spread by the Arabians over the countries of Asia, Africa, and lands bordering on the Mediterranean Sea. It was carried by the Saracens to Spain, Sicily, Italy, and France, from which it gradually extended to the north of Europe, reaching Switzerland, Saxony by the way of the Netherlands, and England in the tenth, and probably the ninth, century. Finally, in the beginning of the sixteenth century, eleven years after the death of Columbus, infection was transported by the Spaniards to Hispaniola, and soon after to Mexico. At the beginning of the sixteenth century it appeared along the Atlantic seaboard, from which it rapidly spread over the American continent. Strange as it may appear, although the principal diseases of the exanthematous group had repeatedly been described and epidemics recorded in various countries, much confusion prevailed concerning them and their relation to each other. Finally, a series of epidemics broke out in London, which, like Rome in the time of Galen, was thickly populated and highly insanitary. The pestilence reigned from 1661 to 1675, and was studied by the masterly mind of Sydenham, who not only established a clear distinction between the various exanthemata, but gave the principles of treatment which were both salutary and rational.

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[61] Withering (William): "An Account of the Scarlet Fever and Sore Throat, or Scarlatina Anginosa," etc. (London, 1779).

[62] Guidi (Guito) (or Vidus Vidius): "Ars. Univ. Med." (Venet., 1596).

The classic production of Sydenham relating to small-pox, measles, and scarlet fever stands as a living monument to his memory, and may be profitably consulted by the student of to-day.

CHAPTER II.

VARIOLA.[64]

(Small-pox; German, *pocken, blattern*; French, *vérole, la petite vérole*; Italian, *vajuolo*; Spanish, *viruelas*; Latin, *variola vel febris variolosa*; Modern Greek, Εὐλογία).

DEFINITION.

VARIOLA is an acute, highly-infectious, and contagious disease,[65] met with in all climates, and characterized by the sudden onset of a high fever, followed, in a few days, by an eruption on the skin, which is the most constant and conspicuous feature. It goes through various stages of development, from macules to pustules, and is finally cast off in the form of variously-sized crusts, leaving more or less cicatrization. The mucous membranes, especially those exposed to the external air, may likewise, though to a less extent, be implicated. It is preceded and accompanied by marked constitutional symptoms, which vary according to the stage and severity of the disease. Like the other exanthemata, it has a latent stage, or period of incubation, and, not infrequently, gives rise to various complications, which co-exist or follow as sequelæ. Its fatality is high, but varies greatly in different epidemics.

VARIETIES.

As previously shown, variola at an early period of its history included the whole exanthematous group. Morbilli was the first to receive recognition as a disease *sui generis*, thus relieving variola of what at one time was regarded as one of its principal forms. Although this process of elimination, which has gone on during the centuries, has simplified the study of the disease, yet it cannot be considered wholly accomplished, for by some writers varicella is still treated of as a variety of small-pox.[66] It is likewise of interest to note, in this connection, that Chinese authors, with their accustomed tendency to detail, describe as many as forty varieties of the latter disease. However, as

[64] For derivation of these words see pages 16 and 17.

[65] In this work a distinction is made between contagion and infection. The former relates to personal touch or contact, from *contingere*, to touch; *contagio*, touching, contact. Infection refers to diffusion or mixing, from *inficere*, to put in, to mix, to permeate.

[66] Among whom may be mentioned Kaposi and Kassowitz.

small-pox is subject to marked variations in appearance, course, and severity, it becomes necessary, in order to obtain a clear conception of the disease, to recognize certain *types*, of which there are three: the *natural*, the *hæmorrhagic*, and the *modified*, or *anomalous*.

The first type is the regular, or normal, form (*variola vera*), which is characterized by a strong tendency to follow a uniform course, and will be treated of as the ideal from which other types and minor clinical forms proceed.

Again, for convenience of description, rather than from clearly defined pathological distinctions, it is customary to recognize certain clinical variations, which may be regarded as subdivisions, or minor *clinical forms*. Thus, in the true small-pox, or *variola vera*, they relate mainly to the distribution of the eruption, which may be discrete (from the Latin, *discernere*, to separate), when the lesions are sparsely scattered over the body; or confluent (*confluere*, to flow together), when the lesions merge, forming large, blister-like areas. Again, the eruption may be confluent on certain parts and discrete on others, in which case it is sometimes spoken of as semiconfluent small-pox. Finally, a condition is sometimes, though rarely, observed in which the lesions show a marked tendency to form groups or clusters on various parts of the body, to which the name corymbose has been applied.

The second type is the most striking of all in appearance, as well as the most fatal. It is called hæmorrhagic small-pox, or *variolæ nigræ* (Sydenham), and presents itself under three clinical forms: the purpuric, the hæmorrhagic, and the exudative, or secondary. The first is characterized by the early appearance of lentil-sized, dark-bluish extravasations of blood into the skin and mucous membranes even before the true eruption of variola appears. The second form appears at a later stage of the disease, extravasation taking place directly into the pocks, giving them a dark-bluish color; less frequently and to a less extent the intervening skin becomes involved. As desiccation supervenes, the cutaneous lesions are transformed into thick, blackish crusts; hence commonly called black small-pox. These two forms are regarded by most recent writers as different degrees of the same condition. The third clinical form, which may be called the exudative, or secondary, is quite distinct from the first two, and is usually seen on the feet and legs of patients who have been allowed to walk about during the course of the disease.

Finally, the third type includes those cases in which the individual susceptibility to the influence of the variola poison is lessened, either

by vaccination, a previous attack of variola, or a natural insusceptibility, giving rise to a modified, or what is sometimes spoken of as spurious, small-pox. In other cases the course of the disease, as well as the development of the pocks, may be interrupted, giving rise to certain other anomalies of less importance, with which we will conclude the clinical description. From these three types and less distinctive clinical forms many deviations occur, and the line of demarkation is not always clearly drawn between them.

That we may obtain a clear conception of the disease we will first consider what may be termed its normal or regular course, when: (*a*) of moderate severity [discrete form]; (*b*) though severe, yet not necessarily fatal [confluent form].

VARIOLA VERA.

(Natural or true small-pox, the normal course of small-pox, *variola vera regularis*.)

SYMPTOMATOLOGY.

The clinical description of variola may be conveniently divided, first, into those symptoms which apply to the disease in general; second, those which are met with only in certain types of the disease. The former will be considered under *variola vera*, while the latter pertain to the hæmorrhagic and modified forms. The symptoms are further divided into groups which appear in regular order and are denominated stages, of which there are five, as follows: Incubation; initial or stage of invasion; eruption; maturation, sometimes called stage of secondary fever; and desiccation or desquamation.

(A) Discrete Form (*Variola Discreta vel Distincta*).

As better hygienic measures obtain it may well be that small-pox, like other pestilential diseases, assumes a milder and less fatal character. Although this supposition cannot be readily verified, yet it is rendered highly plausible when we consider the course and fatality of the affection among various races and in various communities in which the conditions pertaining to the general health are known. This likewise, to a certain extent, explains why the so-called malignant small-pox is now less commonly met with in well-regulated cities than in former times.

PERIOD OF INCUBATION.—The latent period or stage of incubation of small-pox, in most instances, is fairly constant, being from *twelve to thirteen days from the time of exposure,* or reception into the system of the contagium, to the first appearance of the prodromal symptoms. From observations made in the Cleveland Detention Hospital it seems highly probable that the duration of the incubation period, or latent stage, depends largely either on the severity of the poison or on the susceptibility of the person attacked. Thus, in a mild form, it may be delayed one or two days, while in severe and fatal cases it appears promptly on the twelfth day.

In an observation of 1034 cases Curschmann[67] was able in 10 cases only to ascertain with tolerable accuracy the length of the latent stage. This can be determined when it is positively known that the patient has been exposed but once and for a short time. In these 10 cases he found the initial stage of *variola vera* to be from 10 to 13 days, less frequently 14 days, and still less frequently 8 to 10 days. In an examination of 1000 cases with special reference to the prodromal symptoms he was able to observe in 11 cases, or about 1 per cent., certain disturbances during this stage, although they were not distinctive nor of prognostic significance. The stage of incubation is said to be somewhat shorter in hot countries. During this time no apparent change takes place in the general health, although sometimes there is a feeling of malaise, or the patient may complain of having taken a cold, and, while we know that the virus is not entirely inactive during this stage, yet, as a rule, no effect is apparent, either to the patient or his physician.

ACTUAL ATTACK.

THE INITIAL STAGE (*Stadium Prodromorum*).—The onset of the disease is sudden, and is characterized by the violence of the various symptoms, and the rapidity with which they appear. A severe chill or repeated rigors, followed by a rise of temperature, dizziness, nausea, and vomiting, are the usual symptoms at first observed. Furthermore, there is a general feeling of discomfort, with pains and aches in various parts of the body, most notably in the lower part of the back, corresponding to the lower dorsal, lumbar, and sacral regions. This symptom has long been noted as a conspicuous feature of the disease, and the ancients, whose knowledge of human anatomy was somewhat defective, attributed

[67] Curschmann (H.): "Small-pox" in von Ziemssen's "Cyclopædia of the Practice of Medicine" (New York, 1875), vol. ii, p. 341.

it to an "ebullition in the great dorsal vein," while modern pathologists regard it as a congestion of the spinal cord. This striking symptom is not always present. Curschmann observed it in about 60 per cent. of his cases, and in 30 per cent. it was sufficiently severe to be voluntarily complained of. According to the same author, it is more constant in variola vera and in violent or hæmorrhagic cases than in the milder forms of small-pox. This symptom usually appears at the commencement of the initial stage; sometimes it precedes, at other times it follows, the chill, and, as a rule, continues to the outbreak of the eruption. At other times a severe, though undefined, sense of illness is complained of.

Severe frontal headache is another symptom rarely absent at this time. Like the backache, it usually accompanies the chill or comes on soon after, and continues with more or less severity during the initial stage. It has been likened by patients to the sensation of a band drawn tightly about the head, the pains increasing with every pulsation. The only febrile condition with which it is comparable is the onset of cerebral meningitis.

Sometimes there is aching of the long bones, especially at the joints, which is variously described as twisting, or wrenching, and is not infrequently referred to some supposed injury received, or mistaken for articular rheumatism. This is especially so in sporadic cases, or in those which occur at the beginning of an epidemic. Epigastric pain is almost always present and is not infrequently of great severity. It has been mistaken for that due to the ingestion of toxic substances. Moreover, there is loss of appetite, with great thirst; the tongue is furred in the centre and red at the point and margins; the breath is fœtid and the lips are parched. Constipation is almost always present, and continues during the course of the disease, often requiring therapeutic interference. Diarrhœa is sometimes met with in children. Epistaxis is not uncommon. In women the menstrual flow is usually established even between the periods. When pregnancy exists the lumbar pains are often regarded as symptoms of premature labor.

During the first day the temperature rises to 102° or 103° F., without remission on the following morning, and toward the evening of the second day 104° F. (40° C.) or in more severe cases 105° F. (40.5° C.) may be reached. The highest temperature may be observed just preceding the eruption, and usually on the evening of the third day of the disease. Few febrile diseases present the sudden rise of temperature which takes place in variola. In mild cases it continues until the erup-

tion appears, when its decline is equally rapid. In severer forms this amelioration of the fever is slower, more irregular, and the temperature during this stage seldom returns to the normal.

The pulse in robust subjects, especially in men, is full and tense, and ranges in frequency from 100 to 120 beats to the minute. It may be remarked that its frequency corresponds, in the main, to the elevation of the temperature. In children the pulse-rate is usually between 130 and 160. In women and delicate persons it varies from 120 to 140, is more compressible, and is sometimes dicrotic, as in the low fevers.

The respiration is short and labored, and always of increased frequency. As no changes can be detected in the respiratory or circulatory organs at this time, Curschmann attributes these symptoms to the irritating effect of the febrile heat upon the respiratory centres. Congestion of the mucous membranes of the fauces and the upper air-passages, less frequently coryza and congestion of the conjunctiva, may precede or accompany the appearance of the eruption. In those who have been previously afflicted with bronchitis the cough and expectoration ordinarily increase during this stage.

The eyes are dull, the skin is dry and hot, the face is flushed, and the carotids throb. The patient is greatly prostrated, and, within a few hours after the attack, even robust persons find difficulty in standing. If the patient is observed in the erect posture quite a different picture presents itself. Instead of the throbbing carotids and full, flushed face the features are blanched and expressionless. Great dizziness is complained of, with coldness of the hands and feet. The pulse, instead of being full and bounding, as is usually encountered in the recumbent position, is now small and extremely frequent. These symptoms are, however, in proportion to the severity of the disease, and correspond to the degree of fever. As a rule, the pulse-line corresponds to that of the temperature, the two curves running parallel.

The nerve-centres are usually impressed by the variolous poison, and toward the evening of the second or third day the speech is often incoherent, and the mind wanders. Nearly all suffer from sleeplessness and great disquietude.

In children convulsive movements are often seen, varying in degree from a sudden starting up or grinding of the teeth to actual convulsions. One case occurred during the winter of 1898-99 in which severe paroxysms were observed in a girl, aged twelve, who subsequently developed a severe, though discrete, small-pox, with a favorable termination. Sydenham (*op. cit.*) regarded this as occurring more fre-

quently in small-pox than in the other exanthemata, and Trousseau[68] speaks of it as a symptom of diagnostic value.

During the initial stage the urine does not present any characteristic features. It is usually high colored and concentrated, according to the degree of fever. Urea and the urates, as well as the sulphates, are increased. The chlorides are usually diminished, as in other febrile conditions. Creatin, xanthin, and tyrosin may also be present. In severe cases a trace of albumin may not infrequently be detected, and in hæmorrhagic small-pox it is seldom absent, even at an early stage. An abundance of albumin is looked upon as an unfavorable prognostic symptom.

During the stage of invasion, usually on the second day, there sometimes appears what is termed a prodromal rash (*erythema variolosum*). This is subject to great variations in appearance and distribution, and is more frequently met with in some epidemics than in others. In rare instances it precedes the chill and is the first symptom to appear. Furthermore, it may be limited to certain regions of the body (Hebra), or it may be widely diffused (Curschmann). Again, it may be either diffused, as in scarlatina, or blotchy, as in measles, and not infrequently it is mistaken for one or the other of these diseases. The regions most frequently involved in the prodromal eruption are the lower part of the abdomen and inner surface of the thighs. Neither the macular nor the diffuse form evinces any marked preference for particular regions, but often spreads over the greater part of the body. When the erythema is localized, it is usually seen on the extensor surface of the extremities, especially over the joints, generally appearing in the form of a streak extending from the ankle upward, invading the skin over the extensor hallucis longus muscle. In women there is often seen a macular erythema around the nipples alone. This rash, although of variable duration, is evanescent, and usually fades away in from twelve to twenty-four hours, and before the true eruption of small-pox appears. It may, however, be delayed until after the first appearance of the eruption on the face, but fades before the trunk and extremities are attacked, leaving a slightly pigmented furfuraceous surface. From this it may be inferred that the prodromal rash is inconstant, and, when present, is subject to great variability, both as to appearance and distribution. The importance, however, of bearing the subject in mind cannot be too strongly urged, lest its appearance lead to

[68] Trousseau: "Clinical Medicine" (Philadelphia Edition, 1873), vol. i, p. 65.

an error in diagnosis. According to Hebra[69] and Trousseau (*op. cit.*), the regions involved in the prodromal rash remain exempt from the actual small-pox eruption, while Curschmann says the variola lesions rarely ever appear on the lower part of the abdomen and inner surface of the thighs, even when the prodromal rash is absent. While not wholly agreeing with the latter, extended observation leads the writer to believe that the lesions, though not entirely absent, show little tendency to group themselves or to become confluent in the parts forming the crural triangle of Simon.[70] Furthermore, an extensive erythematous rash is usually followed by a discrete variola eruption, and when present is of considerable prognostic value. Finally, it must be borne in mind that the initial stage is subject to certain modifications according to the severity of the disease and the individual peculiarities, and many symptoms here described may vary in severity or be wholly absent. In addition, it is well to emphasize the fact that the subsequent course of the disease cannot invariably be foretold from the initial symptoms.

THE ERUPTIVE STAGE (*Stadium Eruptionis*).—This usually takes place after the third febrile exacerbation, and is seen on the morning of the fourth day. It is somewhat shorter in children than in adults and is prolonged in old age. The eruption is first observed on the face, —the most constant position being the upper part of the forehead,— and consists of pale-red erythematous specks, from a pin-head to a millet-seed in size, which disappear on pressure or when the patient assumes an erect posture. Within a few hours, or it may be simultaneously, deep-pinkish dots appear about the nose, mouth, chin, and hair follicles of the scalp. At the end of, or during, the first day a faint appearance of the eruption may be detected on the hands and wrists. Occasionally this order is reversed, it first appearing on the hands and subsequently on the face. Again, the eruption may first show itself on other parts of the body. This is notably the case when patches of eczema, acne, or other cutaneous inflammatory disturbances exist, in which case the pocks not infrequently appear first on these areas, and throughout their whole course show a tendency to assume a confluent

[69] Hebra (F.): "Diseases of the Skin," New Sydenham Society's transactions (London, 1866), vol. i, p. 242.

[70] This space is bounded above by an imaginary line drawn transversely across the umbilicus, which forms the base; the sides are formed by the lumbar regions, and the apex is directed downward and corresponds, when the knees are pressed together, to a point situated about two inches above the patellæ. Simon (Th.): "Des Prodromal exanthem der Pocken," Archiv für Dermat. und Syphilographie, II Jahrgang, S. 347 *et seq.*

character, while on the normal skin the variolous eruption may be discrete. Thus, a patient entered the Small-pox Hospital during the initial stage with a patch of eczema on the leg, which became thickly covered with the variola lesions, while the sound skin was but discretely attacked. Likewise the eruption tends to become confluent on parts of the body that have been subjected to irritation. Curschmann relates the instance of a patient infested with body-lice in whom the eruption appeared in the form of streaks, following the nail-marks and resembling strings of pearls, the uninjured parts having but few variola lesions. From experiments he ascertained that the injury to the skin must precede the eruption, otherwise no change takes place. On the contrary, Hebra observed in ichthyosis and prurigo that the eruption avoided the parts affected with these diseases, and appeared only on the normal skin: *i.e.*, the flexor surfaces of the joints. Stokes[71] has also called attention to the influence of the local blood-supply on the subsequent small-pox eruption. By reducing the vascularity of the part, by poulticing or other means of depletion, he was able to restrict the number of lesions, even in confluent cases. According to Marson,[72] the eruption is not thrown out at random, but appears in regular order, first on the face and scalp in groups of fours and fives, forming crescents, which sometimes extend into circles; next on the hands and neck; then the back and chest; and finally the arms and legs.

With the first appearance of the eruption the fever rapidly subsides, the temperature remaining normal in mild cases to the end of the disease (*Variola benigna*). This is of great diagnostic importance, as it occurs in no other of the exanthemata. At other times, and in less favorable cases, there is a slight rise in the evening temperature. The pulse in uncomplicated cases corresponds, for the most part, to the temperature, and varies from 90 to 120. The pains previously complained of disappear, and sometimes there is a relish for food, and the patient imagines himself well-nigh recovered. This is usually dependent upon the amount of fever. With the disappearance of sickness and pain the mind regains its normal condition and refreshing sleep is gradually obtained. Profuse perspiration is often seen during the eruptive stage. It varies greatly in different epidemics. It was a conspicuous feature during the epidemic of 1898-1901 in Cleveland. Trousseau regarded it as a favorable symptom.

On the morning of the second day of the eruption the reddish

[71] Stokes (William): Dublin Jour. of Med. Sci., vol. liii, p. 9.

[72] Marson (J. F.): Reynolds's "System of Medicine" (London, 1870), vol. i, p. 226.

PLATE II.

PLATE II.

riola, showing Hard Papular Eruption on the Morning of the Second Day.

PLATE III.

PLATE III.

Variola in the Negro: Papular Stage as Seen Late on Second Day of Eruption

PLATE IV.

IV.

VARIOLA—on the fifth day of the eruption showing marked œdema, erysipelatous redness and the transition of vesicles into pustules. Lesions having a dark central depression have been opened.
Plate II represents the same case taken three days earlier.

specks or dots in the skin of the face are found to be developed into more prominent papules, somewhat resembling flea-bites, and accompanied by a slight sensation of burning and itching. They soon—sometimes during the first day—begin to assume an indurated condition, which gives to the surface a hard, roughened feel when the hand is drawn over the skin. During the second day of the eruption and sixth of the disease the lesions on the face are slightly conical, and to the touch may be likened to duckshot imbedded in the skin. (Plate II.) This feature is usually well marked and of characteristic significance. In the colored race the lesions at this time present a whitish appearance. (Plate III.) With the exception of the hands and forearms, the eruption appears from one to two days later on the trunk and extremities than on the face and scalp, and the feet are the last to be involved. This order continues throughout the whole course of the eruption. After the papules have attained the size of a small pea or lentil on the third day, their summits gradually assume a translucent, glazed appearance, which indicates the formation of a vesicle. As this enlarges a central depression, or umbilication, first takes place, which is looked upon as characteristic of the small-pox lesion. (Plate IV.) It is not always present, and when seen it usually disappears with the full development of the pustules. At this time, if punctured, a small amount of slightly mucilaginous serum exudes. The vesicles thus formed never present the prominent appearance seen in the more superficial lesions of varicella. During the fourth and fifth days of the eruption the vesicles continue to increase in size, and the glazed top gradually assumes an opaque, whitish color. Umbilication at this time is usually well marked.

The eruption is not limited to the skin, but sometimes appears simultaneously on the contiguous mucous membranes at the various orifices of the body. The buccal cavity, nares, and throat seldom entirely escape, and pain, with difficulty of breathing and swallowing, is often a serious condition to encounter.

Stage of Suppuration (*Stadium Floritionis*).—On the sixth day of the eruption and tenth day of the disease the lesions have usually assumed a yellowish tint, from the admixture of pus-cells or polymorphonuclear leucocytes, resembling wash-leather or rich cream. The pocks are about a centimetre in diameter, and project with tense walls above the level of the skin, excepting on the palms and soles, where they are bound down by the unyielding epidermis. Sometimes the integument of the face presents an erysipelatous redness; it is usually swollen

even when the pocks are few. (Plate IV.) This, however, is of short duration, and the skin between the lesions, in the discrete variety, soon returns to its normal color, when an erythematous halo may be seen to surround the pustules. There is occasionally a slight rise of temperature with the full development of the eruption (suppurative fever), due to absorption of pus. Its severity is not always dependent on the number of pocks, but may be the outcome of individual peculiarities, as pointed out by Curschmann, being most frequently seen in delicate persons, women and children. (Plate V.)

On the trunk, arms, and legs little or no œdema is present, and the individual lesions, surrounded with a narrow, though intense, erythematous ring,—which begins with the formation of the pustules,—can be clearly seen. The pustules attain their full development and are of a yellow color on the eighth day of the eruption and twelfth of the disease. (Plate VI.) During one or two days thereafter but little change can be detected, but on the eleventh or twelfth day of the eruption the first indication of subsidence may be seen.

DECLINE.

Stage of Desiccation (*Stadium Exsiccationis, seu Decrustationis*).—The last stage of the eruption begins gradually on or about the twelfth day with rupture of the pustule-walls, thus allowing an oozing of their contents, or by their absorption or evaporation, which constitutes the stage of desiccation. This process takes place first in the centre of the pustule, corresponding to the site of umbilication, forming a brownish scab, which is at first firmly adherent. Finally, the whole lesion becomes transformed into a dark-brown or blackish crust, which gives to the body the appearance of having been bespattered with mire. (Plate XIII.)

The hands follow in regular order, while on the face and scalp the crusts gradually fall off in from three to six days, leaving slightly raised maculæ of a violaceous or reddish hue. Within two or three days the dark crusts, corresponding to the central depressions, are seen on the body, likewise following the order of invasion. It may be remarked that desiccation on the palms and soles begins sooner, and lasts longer, than on other parts of the extremities. (Plate XIV.) The separation of crusts takes place between the sixteenth and twenty-first days. As the crusts drop off a furfuraceous desquamation takes place for a period varying from one to two weeks, after which, if no complications exist, the patient may be allowed to go at large.

PLATE V.

Variola in Negro: Seventh Day of Eruption.

PLATE VI.

Not infrequently the stage of desiccation is complicated by the local infection of the ordinary pus-cocci. In certain cases soon after desiccation begins the variola lesions on the backs of the hands and dorsal surface of the feet become flaccid, lose their yellow color, and extend at the margins by a serous undermining of the epidermis. Not infrequently bullæ of various sizes form, or there may be an accumulation of a viscid, slightly opaque fluid at the periphery, which forms an elevated rim, surrounding a depressed area of shriveled, sometimes shredded, epidermis, in the centre of which a dark, adherent crust, corresponding to the original pock, may be seen. (Plate VII.) The bullous process may extend to the forearms and legs, but only in rare instances does it become more general. It has been observed most frequently in severe cases of discrete variola, and often produces more or less extensive blister-like areas, from blending of the lesions, as in the confluent form. The eruption presents a striking appearance, and its presence may lead to serious error in diagnosis. The condition is identical with that observed in impetigo, especially the bullous form, which was observed so plentifully among the Northern soldiers who took part in the late Spanish-American War.[73] Nor are the conditions which occasion it wholly dissimilar, for in impetigo bullosa we found that the ordinary pus-organisms—notably the staphylococcus pyogenes aureus, albus, and to a less extent citreus—thrived and produced cutaneous lesions which differed in clinical significance under the favorable conditions for the development of extraneous organisms, and the feeble power of the tissues in resisting them, which likewise accounts for the various coccogenous affections met with at this time. In addition to the bullous eruption, as desiccation proceeds, boils, deep phlegmonous abscesses, and, on the legs, ecthymatous crusts, are the most frequent complications of variola. More rarely, erysipelas occurs from inoculation of the streptococcus of Fehleisen. Finally, the absorption of septic material may further retard convalescence and give rise to a general erythema and constitutional symptoms similar to those met with in septic conditions of other diseases.

(B) The Confluent Form (*Variola Confluens*).

This differs from the preceding variety mainly in the severity of its symptoms, the extent of the eruption, and in the fatality of the dis-

[73] The author: "Impetigo: its Clinical Forms, including Ecthyma and the so-called Pemphigus Contagiosus," Cleveland Jour. of Med., December, 1898.

ease. In former times confluent small-pox was far more common than at present, although in certain communities and in certain epidemics it is still the prevailing form. Even when the death-rate is low, if the disease be not checked, certain cases present themselves in which large areas of skin are entirely covered with the eruption. Confluent small-pox is one of the most fatal and loathsome of epidemic diseases, and millions of lives have been sacrificed to its sway. There is nothing peculiar in the period of incubation.

ACTUAL ATTACK.

INITIAL STAGE.—As previously stated, the degree of systemic intoxication, or severity of the poison, may sometimes be observed, even during the initial stage. This, however, is not infallible, for numerous exceptions occur. It may be stated, however, that in confluent variola the initial symptoms are never of a mild character. For the most part, then, the symptoms are similar to those already described, excepting that they tend to greater regularity and are more uniformly severe. The nerve-centres are accordingly more profoundly impressed, and violent delirium in adults and convulsions in children are not infrequently seen. The former oftentimes partakes of a boisterous nature, and physical restraint is sometimes necessary. In children epileptiform attacks may be well marked. The fever not infrequently rises to 105° F. (40.4° C.) or even higher, and vomiting is usually more persistent than in the milder forms. This latter sometimes continues during the whole initial stage. At other times it appears just before the eruption, in which case the prognosis is rendered less favorable than when it appears at the onset. Great prostration is likewise always observed, and the patient may die from collapse at this time (*variola sine eruptione*). The prodromal eruption is seldom seen in this form.

ERUPTIVE STAGE.—The eruption appears sooner than in the milder form heretofore observed, occurring, for the most part, on the third day. Less frequently it occurs on the morning preceding this, or second day. The appearance of the true eruption may be similar to that of the discrete form, and even at this time one may not be able to distinguish between them. The regions first attacked likewise correspond, but in confluent variola new erythematous specks appear during the first and second days between the lesions previously thrown out, until the whole surface of the face is thickly covered, as in Plate VIII. Even yet the papules may be clearly defined, and show little or no tendency

PLATE VII.

PLATE VII.

Variola, Bullous Form, resembling Impetigo.

PLATE VIII.

VIII.

VARIOLA (confluent)—showing erysipelatous redness with indurated papules, third day of the eruption.

to merge. Frequently, however, the confluent nature may be detected from the first, and during the first day the number of lesions may be complete. The skin is swollen, and a deep erythematous color oftentimes gives the appearance of severe erysipelas. The skin is more widely œdematous than in the latter disease, and on the affected surface numerous small vesicles may soon be detected, giving the appearance of a burn. The scalp is swollen and thickly set with pocks, which, on account of their unyielding base, are extremely painful. The hands, forearms, trunk, and legs are, in turn, invaded, but far more rapidly than in milder forms. (Plate IX.) Within thirty-six hours the full quota of lesions is usually complete; in fact, instances are occasionally met with in which the eruption appears almost simultaneously over the whole body. The lesions are red and angry and often show a tendency to run together. The temperature, which, in the preceding or discrete variety rapidly fell to the normal (crisis), now not infrequently shows but little change, although it drops irregularly as the lesions develop (lysis). Rarely does it descend to the normal, but more frequently there is a slight evening rise. It may be stated as a rule that the temperature does not fall below 100° in the morning and 102° F. (38.8° C.) in the evening during the whole course of maturation. As pointed out by Wunderlich,[74] two types of fever are observed in variola: the brief, continuous fever of the milder forms, which subsides with the appearance of the eruption and seldom returns during the course of the disease; and the relapsing fever, which is characteristic of the confluent and severe forms of variola.

The mucous membranes likewise are red and swollen, and frequently dotted with reddish maculæ, which are especially marked on the fauces, tongue, tonsils, and inner surface of the cheeks. The nose becomes early occluded from swelling of the mucous membrane, and the eyes are congested, with much lacrymation and photophobia. Hearing may likewise be temporarily impaired, and a profound sense of illness take possession of the patient.

With the completion of vesiculation the lesions enlarge, come in contact with each other, and merge, forming large areas in which the epidermis appears to be raised into an irregular or corrugated surface as if scalded, even before suppuration takes place. (See Plate X.) The trunk next follows in regular order, and, although the eruption is less abundant, the skin is more or less thickly covered, and in many places

[74] **Wunderlich (C. A.): "Das Verhalten der Eigenwärme in Krankheiten" (Leipzig, 1870), pp. 322 *et seq.***

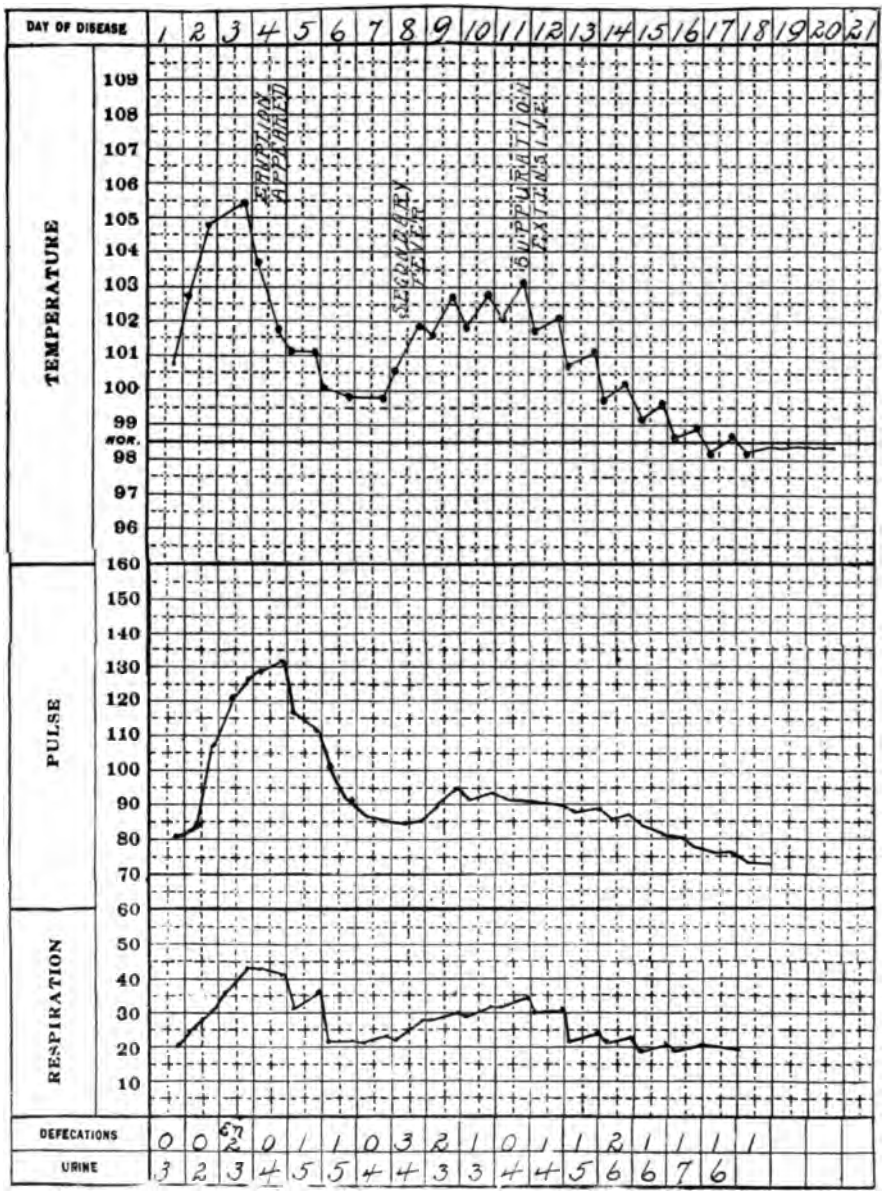

Chart showing High Temperature and Marked Secondary Fever in a Case of Confluent Small-pox terminating in Recovery. (From One of the Author's Patients.)

PLATE IX.

PLATE IX.

Confluent Small-pox, Same as Preceding, showing Lesions on Hand and Forearm the Day Following.

PLATE X.

PLATE X.

Confluent Small-pox: Early Pustular Stage. (Through the Courtesy of Dr. J. F. Schamberg.)

the lesions run together. This varies in degree in different cases. Sometimes large blister-like areas form, with great swelling of the parts and pain, rendering the sufferings of the patient intolerable. Great œdema, either localized or general, accompanies this form. It is best marked on the face, which sometimes loses all semblance of humanity. The hands present the same swollen appearance; the fingers are semi-flexed, and the slightest movement causes the sufferer to cry out with pain. On the palms and soles the pustules are always present, and, as previously remarked, are of considerable diagnostic value, being rarely situated there in the other exanthemata. The feet are greatly swollen and painful, while the legs, and less frequently the whole body, partake of the general œdema, which is proportionate to the confluence of the eruption. This swelling usually lasts from the ninth to the thirteenth or fourteenth days. The great pain complained of in the hands and feet is due to the extreme tension caused by inflammatory products under the dense fascia of the palms and soles.

The older authors attributed great prognostic importance to the swelling of the hands. Sydenham remarks, in speaking of a severe case which he observed: "His only remaining hope being that the swelling of the hands may be of such an amount as to save him from the jaws of death. This sometimes takes place. The swelling of the hands sets in later than on the face, and consequently lasts longer."

On the eighth day the lesions attain their maturity, when serious adynamic symptoms not infrequently supervene. (See Plate XI.) The breathing, which at the beginning of the eruptive stage became easier, is again short and labored. There is not infrequently a marked rise of temperature, which is called the *secondary fever*. This arises from the absorption of septic material, and is usually in proportion to the extent of the eruption. It attains a height of 104° to 106°, and even 107° F. (40°, 41.1°, 41.6° C.) has been observed.[75] It is more constant than in the milder forms, and is usually preceded by a chill and accompanied by great prostration. The pulse, which during the initial fever was bounding and full, now becomes dicrotic, compressible, and often irregular, indicating that the heart's action partakes of the general enfeebled condition. Diarrhœa is often an alarming symptom at this time, and is especially common among infants, while in adults the bowels are throughout the whole course usually constipated, and require therapeutic measures for relief. It would appear from the older

[75] Moore (J. W.): "Small-pox," in "Twentieth Century Practice of Medicine" (New York, 1898), vol. xiii, p. 428.

authors that diarrhœa was formerly far more common in adults than at present. The mind, which partially regained its normal condition upon the appearance of the eruption, again shows marked symptoms of cerebral implication. Prolonged sleeplessness, low muttering speech, and coma not infrequently supervene, or the delirium may be of a violent nature, the patient, imagining himself pursued by some horrible apparition, not infrequently escapes from all restraint and inflicts upon himself some serious injury. The height of the disease is attained between the eighth and tenth day, and at this time the affection is most fatal.[76]

The mucous membranes are always involved, and while more variability is met with than on the external integument on account of the constant maceration and friction to which they are subjected, yet they sometimes closely approximate the typical characters observed on the skin. Thus, in the pharynx and on the tonsils, lentil-sized, dark-reddish spots may first be seen, which gradually become more prominent, and sometimes even vesicular, although when punctured no serum can be detected. About the seventh day of the eruption they appear as opalescent, grayish elevations upon a reddened base. Later, the epithelial covering ruptures, giving rise to excoriated and ulcerated patches. Although the soft palate in most cases seems to be a favorite position for the eruption, it may attack almost exclusively the inner surface of the cheeks or the tongue, which becomes swollen and protrudes beyond the lips. A case recently under observation at the Small-pox Hospital presented typical, yellowish pustules with denuded apices, each surrounded by a reddish base, which was best marked on the tongue and, to a less extent, over the whole buccal mucous membrane. In infants this is an alarming condition, and, as they are unable to nurse, death from inanition is liable to occur. The eruption may also extend to the larynx and trachea, giving rise to hoarseness, dysphagia, and aphonia; or to the nares, completely occluding these passages. When the tonsils are attacked, deep ulcers and abscesses are often formed, accompanied or preceded by œdema of the glottis, rendering the situation critical. Epistaxis is not infrequent, together with salivation, photophobia, and lacrymation. Salivation was regarded as of great importance by the older writers on small-pox, because, like the pustules, it was looked upon as one of nature's methods of eliminating the poisonous humors.

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[76] In an examination of 5000 cases Hebra (*loc. cit.*) found that 35 per cent. attained the greatest severity, as indicated by the pulse, on the tenth day.

PLATE XI.

PLATE XI.

Variola, showing Mature Pustules on the Eighth Day of the Eruption, Confluent on Exposed Surfaces, Discrete on the Trunk.

PLATE XII.

It is now regarded as a reflex, or inflammatory, disturbance of the salivary glands and possibly Steno's duct, having no prognostic significance, although causing much distress on account of the pain attending any attempt at deglutition. For this reason the saliva flows from the open mouth in large quantities, and proves a troublesome complication. Wendt[77] has observed that the eruption sometimes extends to the Eustachian tubes. The eruption is seen less frequently on the mucous membranes of the vulva and vagina, as also on the lower part of the rectum. Like the skin eruption, it is slower to appear and more sparsely distributed on these parts. The urethra is very seldom involved. According to Curschmann, true pustules are never found in the stomach or intestines, although J. W. Moore describes the entire respiratory and digestive tracts as being thickly studded by the variola eruption, appearing as whitish or pearly-gray ulcerations upon a reddish base. On the mucous membranes exposed to the external air the lesions are more fully developed, and finally lead to abrasions of various shapes and sizes.

Although death may end the sufferings of the patient at any time, this is considered the most critical period. In unfavorable cases the pustules not infrequently become flaccid, the face suddenly loses its red, puffy aspect, and the features appear sunken—which by older authors was called "striking in" of the eruption,—the pulse flutters, coma increases, and the patient expires. With this there is usually a rapid elevation of temperature, which, as observed by Simon,[78] continues to rise for an hour or two after death. Within a day or two, if the patient survive, the œdema begins to subside, and the redness of the skin disappears, excepting an erythematous ring, or halo, which surrounds the base of the pustules. This is more pronounced and of a deeper color than in varicella, and is best seen on the trunk, legs, and arms.

DECLINE.

Stage of Desiccation.—After the eleventh day signs of subsidence in the eruption begin to appear, usually by resorption, or rupture of the pustules, the contents of which on exposure to the air rapidly undergo decomposition, giving forth a most nauseating stench, which by some is considered characteristic of the disease. As desiccation pro-

[77] Wendt: "Ueber das Verhalten des Gehörorgens und Nasenrachenraums bei Variola," Archiv für Heilkunde, B. 13, S. 118 und 414.

[78] Simon: In two instances after death it was 110.75° and 112.1° F., respectively. Charité Annalen, xii, B. 5.

ceeds large areas of blackish crusts are formed, as shown in Plate XIII, which restrict the movements of the hands and feet, and give to the face the appearance of being incased in a rough, blackish mask. The swelling gradually subsides, while severe itching sets in to further harass the already-exhausted sufferer. Symptoms of pyæmia are liable to occur at this time, or death may be due to complications arising from severe disturbances of the internal mucosæ, giving rise to pneumonia, pleurisy, or dysentery. Again, death takes place from extreme exhaustion (*variola typhosa seu adynamica* of old authors). In favorable cases the temperature gradually falls to the normal, or it becomes more irregular, when it is of evil augury. With the former change the appetite returns and the eyes are again visible. In some instances it is found that pustules have existed on the conjunctiva; more rarely the cornea is likewise involved, permanently impairing or destroying the usefulness of the eye. Total blindness of both eyes seems to have been far from uncommon in former times. Again, and more frequently, the eyes are found to be uninjured. The tongue clears, and from the fifteenth to the eighteenth day the crusts drop off, leaving reddish or purplish spots, which vary in color according to the condition of the surrounding atmosphere, changing from blue to red. Soon this is replaced by a dark-brownish pigmentation, and the sites of former lesions become depressed, forming deep pits or extensive areas of scar-tissue caused by the destruction of the superficial layers of the skin. (See Plates XV and XVII.) As the crusts separate from the skin, the hair falls out in tufts, either with the hardened concretions or upon the slightest traction. Whether the alopecia will be permanent or not depends upon the depth to which the destructive inflammation has extended. Usually the papillæ are not wholly destroyed, in which case the hair returns. It is not infrequently changed in texture, presenting an appearance of irregular growth; at other times it comes out thick and curly, which may be quite unlike its previous condition. The same holds true of the beard. The nails seldom become implicated, except to a slight degree, and then not sufficiently to interfere with their growth.

In those who survive recovery takes place slowly, and the disease is often complicated by secondary infection of pus-cocci as in the discrete form. In the confluent form, however, this is more general, and the involvement of the internal organs, which is often of a serious character, may lead to permanent impairment of health or terminate fatally.

PLATE XIII.

XIII

VARIOLA—showing desiccation well advanced on the face, with the formation of blackish crusts, desiccation not yet extended to the extremities, twelfth day of the eruption, case same as in Plate XI.

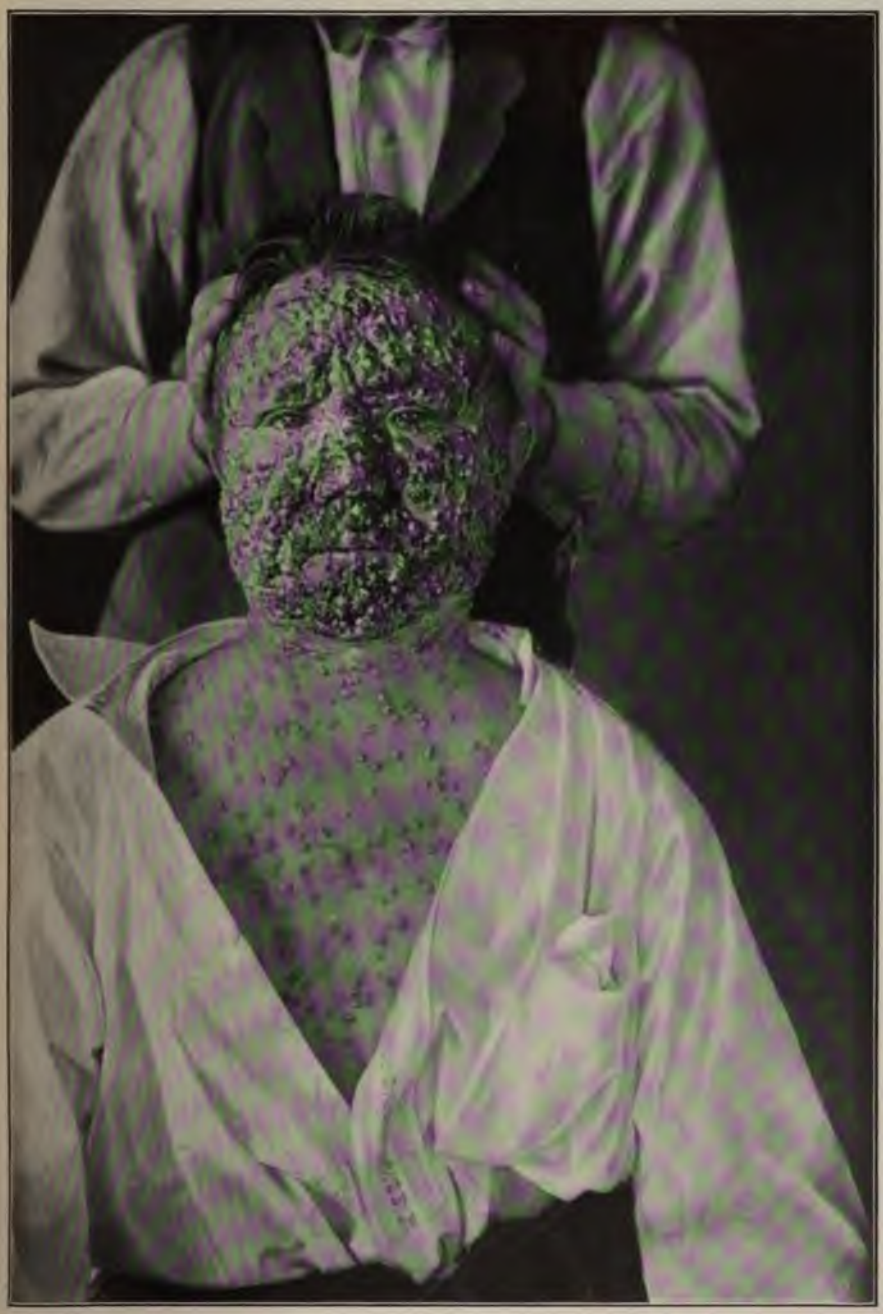
PLATE XIV.

PLATE XIV.

Variola, Same as Preceding, showing Feet, which Present Later Stage of Eruption.

PLATE XV.

PLATE XV.



Variola: Confluent on Face, Semiconfluent and Discrete on Other Parts of the Body. Mucous Membranes of Mouth and Throat Covered with Well-Formed Pustules.

PLATE XVI.

PLATE XVI.

Variola, showing Stage of Decrustation well Advanced. Patient same as in Plates XI, XIII, and XIV.

The Semiconfluent or Coherent Form.

We must not lose sight of the fact that the terms discrete and confluent are purely arbitrary, and that the clinical forms they represent often merge imperceptibly into each other. This is, to a less extent, true of other clinical forms. As its name implies, semiconfluent small-pox is a recognized connecting-link between the two extremes of variola vera. In this country semiconfluent small-pox is one of the most frequent forms, and in some epidemics it represents the severest variety the disease assumes. In the Cleveland epidemic of 1898-1901 it was extremely common, and occurred in those who had either never been vaccinated or in those in whom the vaccination took place in infancy, twenty or more years previously. (Plates XV and XVII.) The face is the part most frequently as well as the most severely involved; next come the hands and forearms. Apparently, surfaces exposed to the light suffer more severely than do those which are protected by the clothing, although the increased vascularity of the part is probably a greater determining factor. The disease, while severe, is not so fatal as the confluent or the corymbose form. In fact, recovery takes place without serious complications in the majority of cases about the fourth week.

The Corymbose Form.

(*Variola corymbosa*, from χόρυμβος, a cluster of fruit.)

This is a rare form, in which the pocks group themselves into variously-sized clusters; hence the name, which was used by Sauvages,[79] who refers to Helvetins as having employed it to indicate a species of malignant aggregation of pustules most commonly met with on the face, while Marson (*loc. cit.*, p. 229) of the London Small-pox Hospital, used it to denote symmetrical groups distributed over various parts of the body.

A case of corymbose small-pox observed at the Cleveland Small-pox Hospital during the past year, from which the accompanying photograph was taken, presented palm-sized clusters, which, when fully developed, assumed the appearance of large, flat blisters. (Plate XVIII.) They were distributed symmetrically on the forearms and legs. On other parts of the body the lesions, while thickly distributed, were discrete. The mucous membranes were likewise involved as in ordi-

[79] Sauvages (F. B.): "Nosologia Methodica" (Lipsæ, 1791), ii, p. 265.

nary small-pox. The case, although severe and somewhat prolonged, pursued a normal course, and finally recovered. During convalescence numerous boils and deep abscesses appeared under the skin on various parts of the body. Sometimes the clusters are smaller, being silver-dollar sized, when they are usually more numerous. In all cases there is a tendency to a symmetrical distribution. According to J. W. Moore, they appear most frequently in the armpits, groins, and the popliteal space. Most observers record a high death-rate in this form. In the London Small-pox Hospital a mortality of 40 per cent. has been recorded.[80] Its fatality is far greater than one would expect from the extent of the eruption. The surface involved is generally less than in the semiconfluent variety, while in fatality it ranks with malignant small-pox. If the patient survive the active course of the disease there is a marked tendency to complications during the stage of convalescence, which is always tedious and prolonged.

VARIOLA HÆMORRHAGICA.

(Hæmorrhagic small-pox, black small-pox, *variola nigra*, *variola maligna*, etc.)

Formerly black small-pox was far more common than at present; in fact, we have reason to believe that it was the usual form in numerous epidemics covering a very long period. In more recent times, from the protective influence of vaccination, and probably from improved sanitary conditions alluded to elsewhere, it is less frequently encountered.

The Purpuric Form.

(Variola purpurica, purpura variolosa, schwarzen tod, etc.)

While it may be impossible to foretell the appearance of hæmorrhagic variola in the majority of cases, yet in the purpuric variety the uncertainty is of short duration; besides there are certain conditions which are known to predispose to this form. Thus, a hæmorrhagic diathesis or the previous incidence of purpura may be considered as strongly predisposing to this variety. On the other hand, it appears in young and robust people who have never had any previous illness to indicate the hæmorrhagic tendency. Next to the natural "bleeders"

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[80] Marson (*loc. cit.*).

PLATE XVII.

PLATE XVII.

Same as in Plate XV After Recovery, showing Permanent Scarification of the Skin.

PLATE XVIII.

Corymbose Small-pox, showing a Cluster of Lesions on Forearm.

purpuric variola occurs most frequently in drunkards, pregnant or lying-in women, and those convalescing from disease or otherwise debilitated.

In the Dublin epidemics of 1871, 1878, and 1894-95, J. W. Moore observed hæmorrhagic small-pox most frequently in young and robust subjects, in muscular men, and women who were either pregnant or had been recently delivered. This variety is characterized by the early appearance and violence of the hæmorrhagic symptoms and by the rapid fatality of the disease. The first indications of its serious nature are met with during the initial stage. The temperature, as a rule, rises more gradually than is usual in variola vera, rarely exceeding 103° or 104° F. (40° C.), and not infrequently 102° F. (38.8° C.) is the highest point reached. Unlike the forms previously considered, the pulse-rate does not correspond to the elevation of temperature, being more rapid and compressible, and not infrequently attaining a rapidity of 145 to 160 beats in the minute. On the other hand, the symptoms may resemble those of variola vera, previously given. There is always, however, intense aching in the back, with great prostration and pain in the præcordial region, accompanied by vomiting, which is prolonged, the ejecta consisting of dark-colored material mixed with bile. In this form the prodromal eruption is of frequent occurrence, and shows a hæmorrhagic character soon after its appearance. Thus, instead of a diffuse erythema which is more common in the mild forms of variola, the prodromal rash now appears in the form of small maculæ of pin-head size and deep-red color, which do not wholly disappear on pressure. Upon close inspection the puncta are found to consist of small hæmorrhages into the lower strata of the epidermis. These enlarge to millet-seed-sized papules of a dark-bluish color, and finally become thickly and widely distributed over the body.

Again, according to Curschmann, large extravasations of petechiæ, situated upon an erythematous base, may sometimes be observed. He further remarks that they are usually small and discrete on the extremities and more confluent on the breast and abdomen, where they sometimes attain the size of a half-dollar. They may, however, be irregularly distributed. They seldom occur on the face, but the skin is red and puffy, and the conjunctivæ are not infrequently blood-shot, and dark rings may be observed around the eyes, due to hæmorrhage into the loose cellular tissue of the parts. This symptom is especially striking and forebodes a rapidly fatal termination. The mucous surfaces share in the hæmorrhagic tendency,

and copious bleeding from the nose is usually an alarming symptom. The mouth is affected in like manner, although to a less degree. The gums are spongy and bleed easily. The tongue is large and thickly coated, presenting a light-yellowish or parboiled appearance. A pseudodiphtheritic membrane is sometimes thrown out on the pharynx, which readily decomposes, giving rise to an intensely fœtid odor. This, with the bloody expectoration and frequent vomiting of blood, accompanied by dark evacuations from the bowels, shows the general and serious character of the disease. The urine is scanty, turbid, and of an offensive odor. Albumin is usually detected early in the disease. In women menstruation is established and abortion often occurs, followed by violent hæmorrhage, which usually continues until death. In all cases there is a rapid, fluttering pulse, indicating the low and serious character of the disease. Death usually takes place at or before this time. If the patient survive the initial stage, there takes place a slow retrogression of the initial rash, and papules, or ill-formed pustules, appear on the face, indicating the advent of the eruptive stage. They soon, however, take on the purpuric character. Seldom does the disease go on to full maturity. Unlike fatal cases of confluent small-pox, the mind, as observed by J. W. Moore, remains remarkably clear until within a few hours before death. Curschmann remarks that few are fortunate enough to fall speedily into delirium or coma. Zülzer[81] has pointed out that a general hyperæsthesia or anæsthesia of the skin, with paralysis of the extremities, sometimes takes place as a precursor of death. The course of purpuric variola is extremely rapid, and death usually relieves the horrible condition from the second to the fifth day of the disease. It is exceptional for a patient to survive the sixth day. Should this occur, however, the maturation and desiccation of the lesions go on much as in other forms, excepting that recovery, which is indeed seldom observed, is very protracted, and followed by anæmia and great prostration for an indefinite period.

The Hæmorrhagic Form (*Variola Hæmorrhagica Pustulosa*).

Neither the previous condition of the patient nor the initial symptoms of the disease furnish any clue to the subsequent appearance of this variety. As a rule, the initial stage is ushered in with great severity and a rapid rise of temperature. The symptoms, however, do not differ

[81] Zülzer: "Beiträge zur Pathologie und Therapie der Variola," Berliner klin. Woch., 1872, No. 51.

from those observed in the confluent form of small-pox.[82] As in the purpuric form, the initial or prodromal rash is of frequent occurrence. It is, however, made up of a deep-colored erythema, with dilatation of the superficial cutaneous capillaries rather than of punctate extravasations of blood. Accordingly, it disappears on pressure, and is more evanescent than in the preceding variety. It usually fades away during the second or third day, leaving a faint brownish, desquamative surface. The true eruption usually appears on the second day, and differs in no way from that observed in variola vera. Sometimes the initial symptoms do not subside with the beginning of the eruptive stage, in which case the temperature either remains the same or continues to rise until death takes place, which usually rapidly follows. At other times there is a gradual subsidence, with great prostration, a weak fluttering pulse, and subnormal temperature. This is not infrequently observed in the aged, and, as in the preceding form, is always a serious omen. With extensive hæmorrhages the temperature may fall to 81° F. (27.2° C.), while the pulse-rate is increased to between 140 and 160 (Curschmann).

In some instances it has also been observed that the development of the pocks takes place more slowly than in variola vera, and not infrequently they never attain their full development. Finally a dark-bluish discoloration is observed at the base or periphery of the pocks, which is first noticeable on the feet and legs. Although extravasation of blood may take place at any time, it is most frequently seen on the fifth or sixth day, or during the stage of maturation. The extravasation is not always confined to the pocks themselves, but sometimes appears in the form of variously-sized ecchymoses between the small-pox lesions. At other times, though more rarely, distinct lentil-sized bluish dots are seen scattered generally over the skin between the small-pox lesions, as in the purpuric form. It may be remarked that this is sometimes confined to the lower extremities, where the disease first appears. On the mucous membranes dark, livid spots are nearly always present. This is more marked in those exposed to light and the external air. Sometimes the so-called diphtheritic membrane also appears in the pharynx and adjacent parts, which, as previously described, rapidly decomposes. Sponginess of the gums, which are of a dark hue, especially at the margin, as seen in scurvy, is likewise observed. Hæmorrhages

[82] Curschmann relates an instance in which a patient suffering from severe epigastric pain, with vomiting and high fever, was sent to the hospital with apparent diagnosis of intussusception. It proved, however, to be the initial stage of hæmorrhagic variola, which rapidly proved fatal (*loc. cit.*, pp. 345 and 346).

from the nose, lungs, rectum, kidneys, and uterus, as in purpura variolosa, appear later. In females metrorrhagia is not uncommon, together with conjunctival hæmorrhages, bloody stools, expectoration of blood, and hæmatemesis as previously described. There is great irregularity in the appearance of these symptoms; many may be absent, and different cases present different degrees of severity. The course of this variety is more protracted than in purpura variolosa, but almost always quite as fatal. Recovery is extremely rare. Usually such cases have but few pustules, or the hæmorrhagic tendency develops late in their course. The absence of hæmorrhage in the internal organs lessens materially the severity and consequent fatality of the disease. According to Curschmann, this form more frequently occurs in older persons, after the prime of life, in those who are debilitated, and in convalescents. Pregnant women are, according to this observer, particularly predisposed to this form.

Secondary Hæmorrhagic, or Exudative, Form (*Variola cum Hæmorrhagiâ Secundariâ*).

This form is quite distinct from the two preceding varieties. It may be regarded as a purely mechanical complication which is usually met with in cases of moderate severity, although otherwise following a normal course. A case recently under observation in the Small-pox Hospital presented a mild form of confluent small-pox. During the early stage of maturation—the patient not being confined strictly to bed—it was noticed that lesions on the feet began to assume a dark-bluish color. This gradually became more marked, and finally completely changed the color of the pustules. The process extended upward to the knees. No other parts of the body were affected. In time nearly all the pustules of this region became entirely replaced by a dark-bluish fluid. The patient made a good recovery, although the large excoriations on the feet retarded convalescence, and necessitated his remaining in a recumbent position for many weeks. It is usually observed in people who, either in delirium or otherwise, assume an erect position when in a weakened state, the extravasation being the result of debility rather than of any predisposition or abnormal tendency to hæmorrhage. Curschmann (*loc. cit.*, p. 370) speaks of it as not uncommon in delirious patients who leave their beds and run about, and relates the case of a girl, twenty-one years of age, who entered the hospital during the suppurative stage of a mild attack of discrete variola, with the ominous diagnosis of "Variola nigra." Upon investigation it was found that

the disease had been running a normal course until under the influence of a slight delirium potatorum, being poorly attended, she left her bed and rambled about the room during the entire night and a greater part of the following day, when it was observed that nearly all the pocks on the feet and legs up to the thighs were filled with blood.

VARIOLA MODIFICATA.

(Varioloid, modified and anomalous small-pox, *variola mitigata*, *variolæ anomalæ*.)

Small-pox, as previously shown, does not always follow a uniform course, nor is it of equal severity in all persons attacked. In severity it likewise differs in different epidemics. Undoubtedly individual peculiarities have much to do in determining not only the severity of the disease, but also its duration and clinical features. We occasionally meet with persons who seem to possess a natural immunity to the contagion,[83] others in whom the disease assumes a mild form, even when not under the protective influence of vaccination or a previous attack of variola. Since the introduction of vaccination, however, these modified forms of the disease have become far more common. In fact, at the present day, with general vaccination in vogue, varioloid is not only the most common, but of the greatest importance to the physician, on account of its harmless appearance and the difficulty of maintaining strict quarantine regulations. For we must not lose sight of the fact that all forms of small-pox are essentially the same, and the source of contagion, whether it be from a mild or a malignant case, affords no criterion as to the form the disease may assume in those exposed. Those who cherish the thought that the disease itself has undergone modification, must at intervals find this fond hope dispelled by an epidemic of old-time severity. This was especially the case in Montreal in 1885, when the general prejudice and neglect of vaccination led to one of the severest epidemics of recent times. Some epidemics, it is true, present only the mild or modified forms of the disease, or at least symptoms so mild as to render the diagnosis of many cases confusing to those who are not thoroughly familiar with it. In every epidemic there are, however, certain individuals who develop the severer forms of variola, showing that the poison is the same in each. Varioloid is, therefore, a mild form of small-pox usually occurring in those who have been vaccinated or have previously had the disease. It is a fact commonly observed that

[83] Morgagni, Boerhaave, and Diemerbrock, it is said, possessed this peculiarity.

vaccination protects against the development of the variola poison for a certain, though variable, period. Gradually the time arrives when the system loses the complete protective influence of vaccinia, and, if exposure take place, a mild form of variola develops, which is called varioloid.[84] Likewise one attack of variola usually confers a life-long immunity to the disease.[85] After the lapse of many years, however, occasional exceptions occur. Thus, it is commonly reported that Louis XV of France suffered from small-pox at the age of fourteen, and contracted it again when sixty-four years old, from which he died. This instance is frequently cited, because it not alone presents an exception to the rule of complete life-long immunity, but apparently to the mild nature of a second attack as well. Hebra, it may be remarked, held strongly to the opposite opinion, for he says: "I have repeatedly had occasion to observe that persons who had before been attacked by variola, and who presented the most marked cicatrices, have died of this complaint when seized with it for the second time in a severe form" (*loc. cit.*, p. 263). Hebra, it must be remembered, made no distinction between varicella and variola. Trousseau likewise relates the case of a medical student who, although he had previously suffered from two attacks of small-pox from which he was badly pitted, contracted it a third time in a moderately severe form. Mason Good,[86] on the contrary, observed only the crystalline form of horn-pox in second attacks of variola. I believe the weight of authority, and especially the testimony of those who have had most to do with variola in this country, confirms the statement that small-pox, when occurring a second time in the same individual, is usually of a mild or modified character, and when not complicated by old age or other debilitating conditions is seldom fatal.

The disease presents greater variability both in the duration of its stages and in the appearance of the eruption than is seen in variola vera. The fatality of the disease is low, and, as a rule, it is of shorter duration than in the forms previously described. The premonitory symptoms may be severe, and the temperature not infrequently rises to

[84] Varioloid was formerly thought by some to be a distinct affection resembling variola, while, according to Rayer, the term was first used by Thomson, of Edinburgh, in 1820 to include varicella and all mild affections which he supposed to be modifications of the variola poison. Rayer (P.): "Traité Maladies de la Peau" (Paris, 1835), tome i, p. 577.

[85] According to Marson (*loc. cit.*, p. 243), during the one hundred and nineteen years since the founding of the London Small-pox Hospital not a single instance has been recorded of a patient being admitted with small-pox a second time.

[86] Good (Mason): "Study of Medicine" (New York, 1827), vol. iii, p. 78.

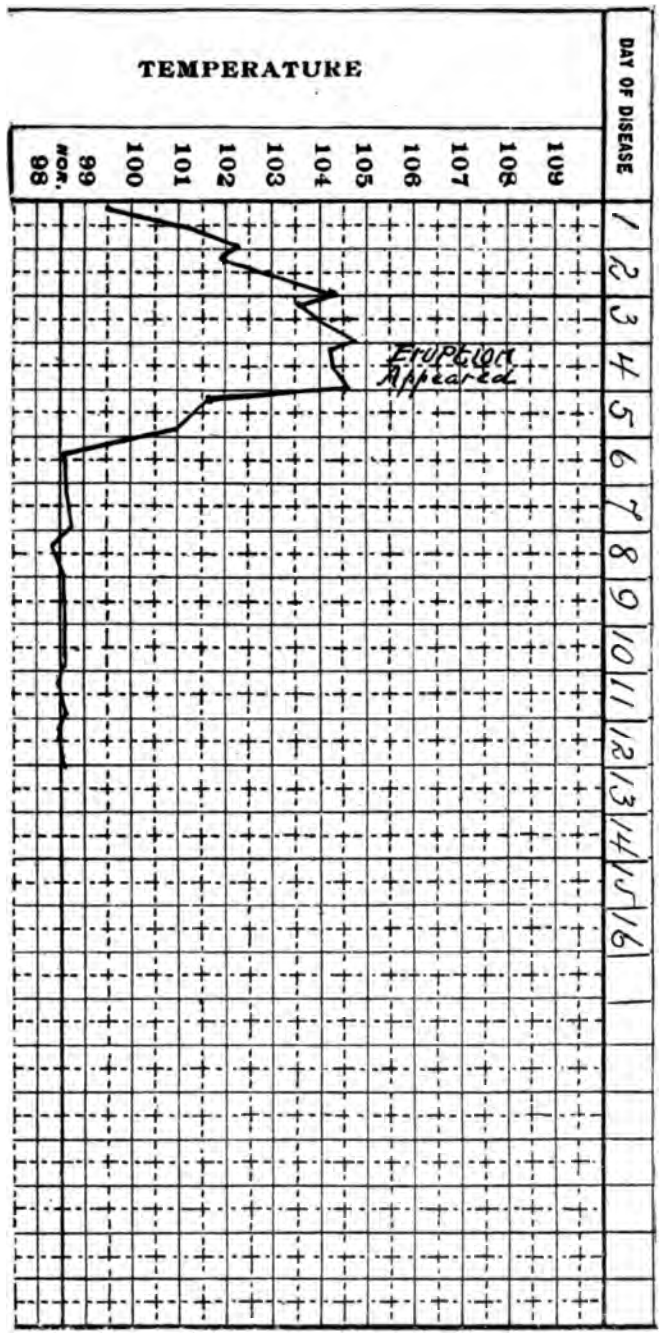


Chart showing Temperature in a Case of Varioloid. (From One of the Author's Patients.)

104° F. (40° C.), or even higher. As a rule, however, the intensity of the disease is seen to be modified even in the initial stage, and the usual symptoms are less constant. Sometimes they consist only of frontal headache, at other times of nausea and vomiting, although pain or aching in the back is seldom wholly absent. The initial stage is of longer duration than in variola vera, the eruption appearing on the fourth day, although it may be delayed until the morning of the fifth day. The eruption may sometimes be seen as early as the second, or in very rare instances on the first day of the disease.

With the older writers, Trousseau (*op. cit.*, pp. 86 and 87) claimed that the initial roseola was seen only in varioloid. While, as previously stated, great variability is shown in different cases, and in different epidemics, yet there can be no question that the erythematous initial eruption is more frequently met with and more widely distributed in the mild than in the severe forms of the disease. Its presence, therefore, is of prognostic significance. It is well to bear in mind in this connection that the petechial rash which so frequently precedes the hæmorrhagic and fatal form of variola is never encountered in varioloid. Curschmann, whose wide experience enables him to speak with authority on this subject, does not remember having seen variola vera follow a well-marked simple initial erythema (*loc. cit.*, p. 377). With Hebra and Trousseau, he also believes that the subsequent development of the pocks is less severe according as the initial eruption is more extensive.

The disease may terminate with the initial stage (*variola sine variolis*) and the patient recover within from three to five or six days. These abortive attacks not infrequently follow well-marked and even severe initial symptoms. Such cases have been recorded by Hilton Fagge,[87] Landucci,[88] Simon, Marson, and Curschmann. The last-named especially offers evidence which seems convincing. Thus, a woman during an epidemic of variola was suddenly seized with shivering, fever, and headache. This was accompanied by a severe pain in the back, which rendered the diagnosis of small-pox well-nigh certain. After the initial stage, on the fourth day, defervescence took place, although no rash could be detected, and on the tenth day she was pronounced well. Soon after this she gave birth to an infant which was covered with an early eruption of variola, which went on to suppuration and proved fatal.

[87] Quoted by J. W. Moore (*loc. cit.*, p. 423).

[88] Landucci, cited in London Lancet, 1871, i, p. 56.

Marson[89] likewise reports the case of a lady who came in contact with a person affected with small-pox. Twelve days later she was seized with a severe illness, accompanied by high fever and delirium. This subsided on or about the fourth day, and she recovered without further symptoms of variola. Twelve days after this, however, a sister who had not been out of the house for some months was attacked with variola which assumed a confluent form. The present writer has likewise observed such cases during epidemics of small-pox.

At other times the eruptive stage appears, and the pocks during the first day become acuminated and progress no further (*variola cornea*, or *horn-pox*), or are surrounded by a small vesicle which does not develop into a full-sized lesion, but soon begins to shrivel without signs of suppuration, forming a reddish papillary, or wart-like eruption which is called *wart-pox*, or *variola verrucosa*. This form is best marked on the face, where the lesions are often quite numerous, while but few are usually seen on other parts. This variety is of short duration and its whole course does not exceed ten days, and is frequently less. When the eruption ends with the full development of vesicles, it is called crystalline small-pox, or *variola crystallina*. The name *variola miliaris* is applied to a more common anomaly in which there appear either on the initial eruption, or later, between the more mature pocks, small millet-seed-sized vesicles which take on a slightly yellowish tint, and desiccate without developing into full-grown lesions. They are liable to render the nature of the eruption obscure. Sometimes there is a retrogression of the pustules, in which case their contents become absorbed, leaving empty shells containing only air, to which the term *variola siliquosa* is applied. This has been observed likewise in variola vera, when it is of more serious import. Aside from these abortive forms, varioloid more frequently goes through the various stages of development and desiccation.

On or about the fourth day the eruptive stage begins with the appearance of reddish dots, as in variola vera. These are likewise most commonly observed first on the face and subsequently on the trunk and extremities. There are numerous exceptions, far more than in variola vera, and this order may be reversed. On the face, however, the eruption is always more abundant and is usually grouped or in clusters, especially about the nose and mouth. With the appearance of the eruption the temperature rapidly subsides and within a day or two returns

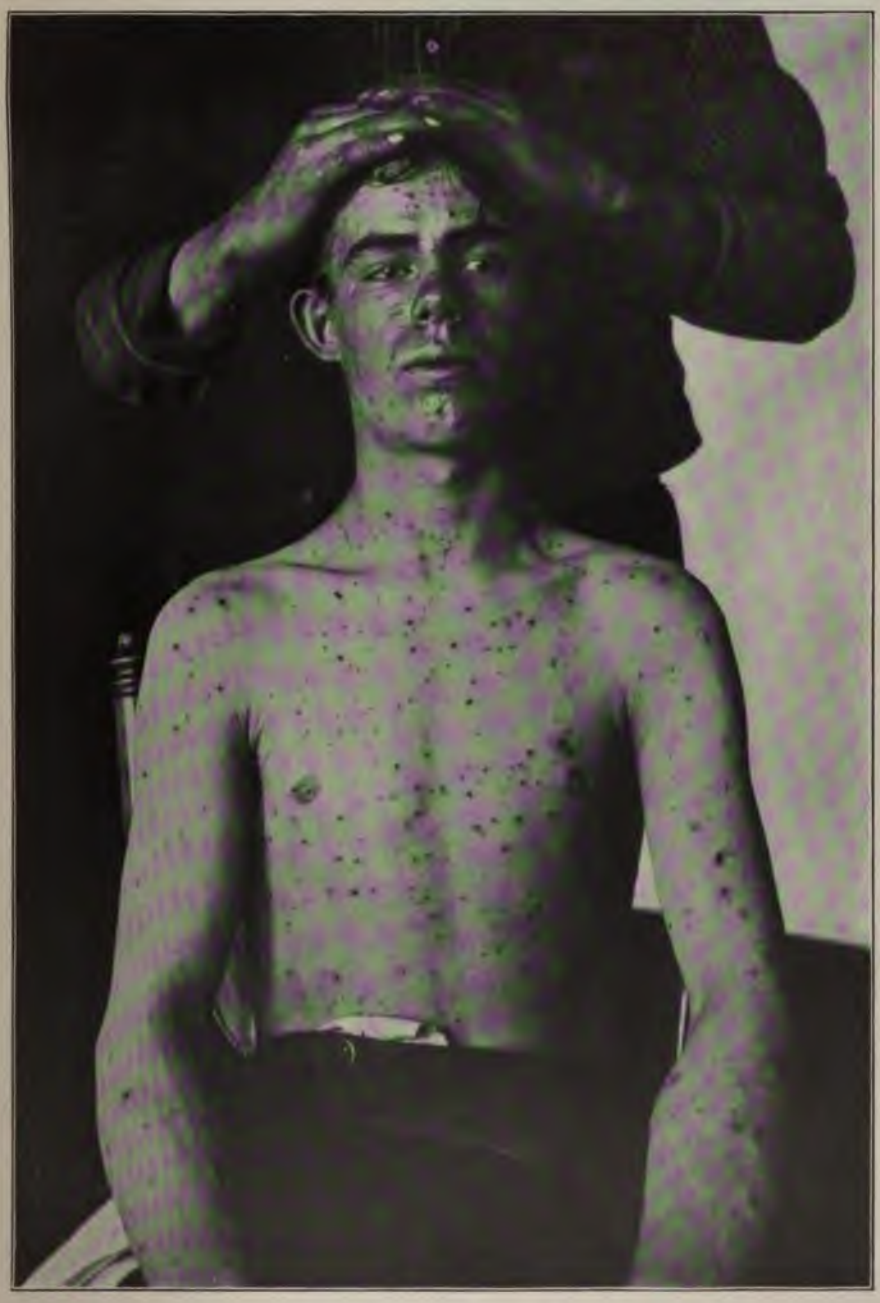
[89] Marson, quoted by J. W. Moore (*loc. cit.*, p. 423).

to the normal. Other initial symptoms likewise disappear, and often the patient can with difficulty be restrained from going about. At the end of the first day, or more commonly during the second, small vesicles appear on the summits of the conical papules. At this time I have repeatedly observed lentil-sized pustules on the trunk, which do not present the appearance of well formed pocks, but resemble small blisters containing a sero-purulent fluid, situated on the normal skin. (Plates XIX and XX.) They present neither induration nor surrounding areola, and when punctured they completely subside and no reaccumulation takes place. This has led some to look upon the affection as varicella rather than varioloid.

Case I.—A girl, aged twenty-three, complained of slight malaise, accompanied with some distress in the stomach and followed by fever, which gradually attained the height of 104° F. during a period of three or four days. Following this an eruption appeared, although the medical attendant, who had discontinued his visits upon the subsidence of the fever, was not notified until about three days after the eruption was first observed by the patient's mother. There being some doubt as to the nature of the affection, I was called in consultation, when an opportunity was given to study the eruption. Upon examination the patient was found to be in a fairly comfortable condition, her appetite was unimpaired, and no pains or aches were complained of. On the face, grouped about the nose and mouth, were about a dozen reddish papules, the size of small peas, some of which presented an opalescent, glazed top. On the trunk, especially between the shoulders, were a few lesions, pustular in character, presenting the appearance of thin-walled blisters, which varied in size from a pin-head to that of a small pea. Many had ruptured, leaving a flattened, excoriated base covered with epidermic *débris* and crusts. No induration was present. There were also a few small papules and slightly opalescent vesicles. On the arms and legs the lesions were also pustular, but indurated at the base, and could not be completely obliterated by puncturing. On the palms of the hands and the soles of the feet there were likewise one or two deep-seated lesions. The pharynx was slightly congested, otherwise unaffected. There was marked debility, considering the number of lesions, and when requested to stand the patient could do so with difficulty, complaining of faintness. On the face, however, the lesions were deeply seated, becoming vesicular and going through the various stages in a regular way, although more rapidly than in variola vera. The special features were: The variability in the character of the lesions and the

PLATE XIX.

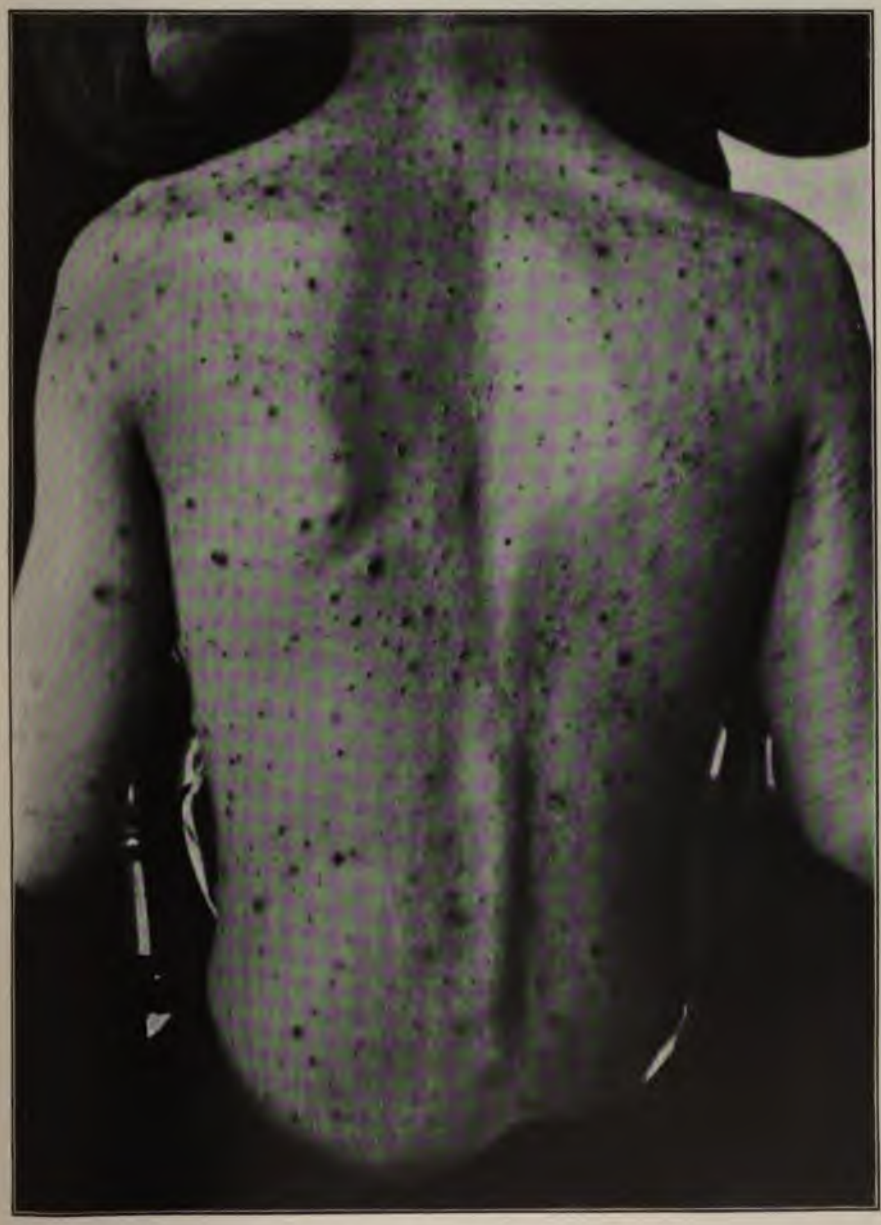
PLATE XIX.



Varioloid, presenting Multiform Lesions resembling a Syphiloderma or Varicella.

PLATE XX.

PLATE XX.



Varioloid, Posterior View of the Preceding.

irregular order in which they developed. She was sent to the Small-pox Hospital, and in about eight days desiccation was well-nigh complete. The patient had never been vaccinated, and to remove a lingering doubt on the part of some as to the correctness of the diagnosis instructions were given to the resident physician that she be guarded against vaccination while in the hospital. A week after she entered the Small-pox Hospital another member of the family was seized with variola of a mild, although more pronounced, type.

Case II.—A girl, aged twelve years, who had never been vaccinated, complained while at school of smarting of the eyes and sensitiveness to light. The following day the family observed that she was feverish, having an intensely flushed face, and complained of headache, which was followed by slight nausea and vomiting, the latter being attributed to cream and jelly which the patient had eaten. The family physician was called and noted a slight rise of temperature and a papular eruption on the face. At this time the patient did not complain of feeling ill, and the case was regarded as one of varicella. Some disagreement arose as to the correctness of the diagnosis, and I was asked by the health department to see the case. I did so with the family attendant, and although unable to obtain a definite history of the previous course of the disease, yet did not hesitate in pronouncing it variola. At this time the lesions were numerous on the face, and especially well marked about the nose, mouth, and forehead. They were pustular, with an indurated, reddish base. On the trunk they were less numerous, and in many instances had ruptured, leaving lentil-sized or larger excoriated areas. There were also small pustules varying from a pin-head to a lentil in size, together with a few small papules. The following day the family attendant informed me that the lesions had greatly changed and a second examination he thought would compel me to render a different opinion. Accordingly, twenty-four hours later, the case was again seen. At this time the pustules on the face were rapidly desiccating, apparently by resorption of their contents. On the hands and forearms the lesions were full and had not undergone any perceptible change, excepting that they had increased slightly in size. On the palms of the hands and soles of the feet there were a few deep-seated whitish pustules. On the trunk there was a variety of lesions, many of which presented small, blister-like pustules situated on normal skin, without induration or inflammatory margin. When punctured with a needle these anomalous pocks discharged their contents and completely flattened to the level of the skin. Slight friction removed

the flaccid epidermis, leaving an excoriated area quite unlike the lesions of variola vera. As the same opinion was entertained as to the nature of the disease she was sent to the Small-pox Hospital. The following day at the same hour a more thorough examination than had previously been possible was made in the hospital ward. At this time the lesions on the face had undergone marked desiccation, and many of the pustules on the trunk had disappeared, leaving crusts of varying thickness and consistency. A few remaining lesions presenting the non-indurated, blister-like character previously described were also found on the arms and trunk. These subsided upon puncture as before. Other lesions which were more fully developed, presenting the usual character of a variola pustule, were likewise seen. The latter did not subside on puncture, and scraping away the pustular covering left an elevated, ragged, somewhat indurated base: the true small-pox lesion. The hospital physician was instructed not to vaccinate the patient, although, to remove all uncertainty in his mind, and without authority, he inoculated the patient with the variola virus. A brother, two years younger, was attacked four days later, and presented more characteristic lesions. When first seen they were papular and the next day vesicular, and when he entered the hospital they were well formed pustules. Both cases made a rapid recovery, the disease lasting about ten days. The variola inoculation in the first patient, it may be remarked, gave a negative result.

The severity of the constitutional symptoms, the *deep-seated nature of the majority of the lesions*, will in most cases enable one by careful study to arrive at a correct diagnosis. Secondary fever is never seen in varioloid excepting from some concomitant condition. From the fifth to the seventh day desiccation begins. The pustules seldom rupture, but the contents undergo retrogressive changes, becoming smaller and finally form dark-brown crusts, which in a few days are cast off, leaving reddish, slightly pigmented spots. The mucous membranes are likewise sometimes involved, most frequently the pharynx and palate. There may be but a simple erythema, or distinct lesions may at times be discerned. The tongue in most cases is thickly coated, although it does not swell as in variola vera. Recovery takes place in the majority of cases within a fortnight, and complications and sequelæ seldom occur.

The Inoculated Form.

When a susceptible individual is inoculated with the pus of small-pox, the following symptoms take place: In from one to two days there

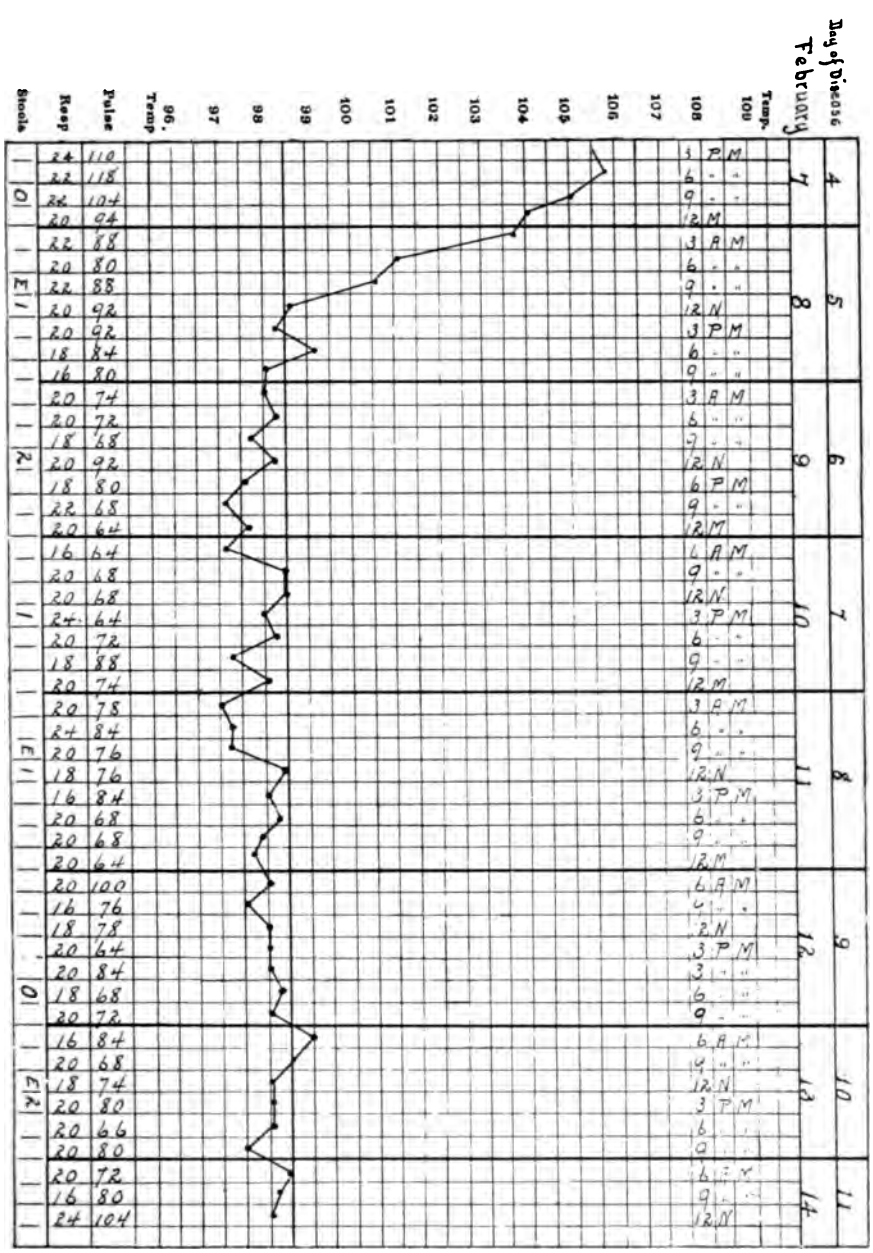


Chart in Varioloid, showing High Prodromal Fever, followed by Subnormal Temperature. (From One of the Author's Patients.)

is a slight redness at the point of inoculation, such as might result from a simple irritation. During the following three or four days œdema, with the formation of a papule, is observed. This soon develops into a pustule, which resembles somewhat that of variola. On the sixth day a dull pain is felt in the axilla, and on the eighth day the patient feels ill and the initial somatic symptoms set in. In many respects they are similar to those observed in the initial stage of the other forms of variola, excepting that they are almost uniformly of a milder nature. The fever does not attain the height previously noted in other forms, and vomiting, prostration, and delirium are usually absent. There is usually some sickness, which is referred to the stomach, with pain in the back and frontal headache. The various stages of the disease are shorter than in the natural form, and the rash appears on the third day. It follows in regular order similar to that observed in the discrete form of variola vera, first appearing on the face and head, then on the hands, trunk, and extremities. Its invasion is more rapid, and not infrequently even during the first day the outbreak may be complete. Some variability also exists in this form, for. while the majority of cases follow a short and favorable course, others are severe and some confluent. On the sixth or seventh day the lesions are usually complete, and desiccation takes place soon afterward. There is usually very little or no secondary fever, and by the thirteenth or fifteenth day the crusts are, for the most part, cast off, and recovery is complete. The mildness of the attack was early recognized, and the custom of inoculating with the virus of small-pox was adopted at a very remote period, as elsewhere shown. Even in modern times the custom was wide-spread, and many now living can recall the time when it was universally practiced in the British Isles and in America. From the great fatality caused by the more extensive diffusion of variolous contagion among those who were not inoculated, as well as from the fact that inoculation does not always insure a mild attack, it was finally discarded and laws were enacted against its practice. The introduction of vaccination, however, has entirely superseded it, and "sowing" or "buying" the small-pox is now regarded as a relic of semibarbaric times.

COMPLICATIONS AND SEQUELÆ.

In addition to the complications which modify the symptoms of the disease already described, variola frequently gives rise to conditions which call for further consideration.

The Skin.—One of the most constant conditions following the

various forms of small-pox is the deposition of pigment in the areas of skin previously involved in the variola process. It appears in the form of maculæ having a distinct border, and varying both in shape and size according to the former small-pox lesion. After their disappearance, whitish cicatrices are seen, due to the destruction of the papillary layer of the derma. It was formerly the custom to bind the hands, or inclose them in mittens, to prevent injury to the skin from scratching. This is now known to depend more on the depth of the destructive inflammatory process than to any irritation caused by the finger-nails, although the introduction of extraneous substances may be facilitated and the inflammation aggravated by vigorous scratching. The phlegmonous abscesses of the skin and subcutaneous cellular tissue may persist long after the true small-pox lesions have disappeared. J. W. Moore relates an instance in the Dublin Fever Hospital, in which as many as forty-two abscesses followed a case of confluent small-pox, and the unfortunate sufferer was confined to the hospital for nine months before recovery took place.

In the Cleveland Small-pox Hospital we have not infrequently seen large subcutaneous abscesses, more protracted and withal of greater danger to life than the attack of variola which preceded them. In mild attacks, especially when the patient has been allowed to walk about, or to sit with his feet on the floor, the legs have most frequently been the seat of these coccogenous sequelæ. When the disease has been more severe, as in confluent variola, various other parts of the body show an equal tendency to their formation. Thus, the arms, scalp, neck, and trunk may be involved, or occasionally the deeper cellular tissues, as in the axillæ or about the rectum, giving rise to an abscess which may occasion an ischio-rectal fistula. Codina Castellvi[90] has observed a psoas abscess in a convalescent from variola.

Although the pus-organisms may cause extensive destruction of various parts, yet gangrene is seldom observed, excepting occasionally in the scrotum and over bony prominences subjected to constant pressure, bed-sores forming as in other diseases. Marson has observed gangrene of the genitals as of frequent occurrence in women of the town afflicted with gonorrhœa. Loss of hair sometimes takes place, which is either temporary or permanent according as the hair papilla is or is not destroyed. Obstinate pustular acne and sycosis vulgaris in men are among the most common sequelæ of small-pox.

[90] Codina Castellvi: An. de Obst., Ginecopat., y Pediat. (Madrid, 1898), xviii, pp. 193-201.

The Eyes.—Although the eyes suffer less commonly than from the older authors we are led to believe took place at one time, yet permanent impairment of vision is far from infrequent, and the importance of close attention to the eyes during an attack of variola cannot be too strongly urged. In 5000 cases of variola Hebra (*loc. cit.*, p. 254) found the eyes involved in only 1 per cent., and in none did it lead to impairment of sight. While this is regarded by most authors as a unique experience, it has served to stimulate original research and closer observation in this direction.

Aside from catarrhal or simple acute conjunctivitis, which is common after all forms, great disfigurement of the eyelids is sometimes observed after confluent small-pox. This may be the result of sloughing from œdema of the lids, or the pocks may give rise to cicatrices which differ in no way from those observed on other parts of the face, excepting that by contracting they occasion greater deformity.

Marson (*loc. cit.*, p. 234), in reviewing the notes of 15,000 cases of small-pox, found only 26 instances in which the primary small-pox pustule had been formed on the eye. In none of the patients thus affected did permanent injury to the eyes occur. The conclusions arrived at by this observer were: That the ulceration which leads to destruction of the eye in small-pox begins after the secondary fever has commenced, varying from the tenth to the thirteenth day, most commonly the twelfth. It appears with redness and slight pain in the part affected, followed shortly by an ulcer having its seat invariably at the margin of the cornea. This spreads, its rapidity being in proportion to the secondary fever present. The different layers of the cornea are destroyed and the aqueous humor escapes. If the opening be large the iris may be seen protruding, and sometimes the crystalline lens is detached and flows out with the vitreous humor. The process in severe cases with high fever takes place rapidly, the entire cornea being swept away in forty-eight hours; and, as but little pain is felt, the destruction of sight may take place before the serious nature of the affection is detected.

According to Horner,[91] of Zürich, who studied the subject exhaustively during the epidemic of 1871, pustules on the cornea are extremely rare. The most frequent, as well as the most serious mode of attack, according to this observer, is an infiltration into the conjunctiva of a grayish-yellow color, which takes place at the lower

[91] Horner, quoted by J. W. Moore (*loc. cit.*, p. 432).

margin of the cornea and rarely, if ever, extends to the fornix conjunctivæ or far along the inner or outer margins of the cornea. It is met with in the eruptive stage, and clinically is identical with the regular small-pox lesions. Like a solitary marginal phlyctenula, it leads to an affection of the cornea, forming either a marginal ulcer or a deep purulent infiltration. This, in turn, eventuates in perforation, staphyloma, purulent iridochoroiditis, and panophthalmitis. From the position of the eyeball when the lids are closed, as is usual in this stage, Horner believes the morbific substance gains access to the conjunctiva from without. I have encountered this complication but once.

Keratitis is likewise met with late in the course of variola or as a sequela. Unlike the preceding, this is not associated with the eruptive stage, but results more commonly from atrophy due to impaired nutrition. The term "atrophic keratitis" is sometimes applied to this form. Ernst Fuchs[92] regards metastasis (the germs circulating in the blood) or endogenous infection as the most frequent cause of ocular complications met with in small-pox, scarlet fever, and measles. In variola the abscess frequently does not form until desiccation is far advanced, or even after patients have left their beds; hence they must be regarded as distinct from the true variola pustule. Metastatic abscesses are met with both in children and adults, and may affect both eyes, causing total blindness. This, however, should not be confounded with small-pox pustules which develop on the tarsal conjunctiva, generally near the intermarginal line, nor with pustules which form on the conjunctiva of the eyeball, near the limbus. These, it may be remarked, are of serious moment, because they frequently give rise to a purulent keratitis in the adjoining cornea.

Horner further observed, as true post-variolous affections of the eye, diffuse keratitis, iritis and iridocyclitis, with opacities in the vitreous humor, and glaucoma. Finally, there may result extensive suppuration of the globe, panophthalmitis, leading to septic infection of the choroid and retina, causing complete loss of sight. In hæmorrhagic variola hæmorrhages may take place into the conjunctiva, or behind the retina, detaching it and causing blindness.

The Ears.—It has long since been a matter of common observation that small-pox occurring in an individual afflicted with some pre-existing disease of a chronic inflammatory nature will exhibit an unwonted severity on the parts thus affected. This applies to other organs

[92] Fuchs, quoted by J. W. Moore (*loc. cit.*, p. 433).

than the skin. When small-pox supervenes on any inflammatory or catarrhal affection of the middle or internal ear, impairment of hearing or actual deafness may result. This is usually due to an acute or chronic suppurative otitis, to caries of the ossicles of the ear, or to suppurative thrombosis of the cerebral sinuses. The latter is, for the most part, an extension of the disease from the middle ear through the mastoid cells to the dura mater. This may eventuate in cerebral abscesses or purulent embolism of other organs.

Stokes[93] attributes deafness occurring in typhus fever, and sometimes following small-pox, to a paresis of the auditory nerve, leading to an acute degenerative softening of the intrinsic muscles of the ear. It must not be understood that these grave disturbances of the ear are of frequent occurrence; on the contrary, a slight catarrhal condition more frequently ensues, which, as health is restored, completely disappears.

The Nervous System.—The nerve-centres are from the first affected by the variolous poison. Functional disturbances at this time are seldom absent, while structural changes are by no means uncommon. The latter may occur as complications or sequelæ. During the epidemic of 1898-99 a case occurred in which an attack of acute mania set in early in the course of the discrete form of small-pox. The patient had never previously suffered from any brain disturbance, although he was not considered to be endowed with unusual mental vigor. When taken to the hospital he was able to sit up, and, it is reported, smoked a cigar on the way. The following day, being the fourth day of the eruption, he was seized with a desire to demolish everything within reach; so that physical restraint was necessary. He continued violently insane until death, which took place about six days later. Whether or not the fatal termination was brought on by natural causes, or was the result of a thermometer which he had inadvertently swallowed before the attendant realized the serious nature of his mental derangement, is not known, as an autopsy was not permitted.

Trousseau likewise mentions the case of a woman who, during the progress of modified small-pox, was seized with acute mania without any premonitory symptoms of mental disturbance. Three cases of this nature are also reported by Seppilli and Maragliano.[94] Of these, one remained incurably insane, while the remaining two recovered. In this connection these observers relate an instance of a violent maniac confined for treatment in a lunatic asylum who was seized with small-pox,

[93] Stokes (W.), quoted by J. W. Moore (p. 433).

[94] Seppilli e Maragliano: "Della Influenza del Vajuolo sulla Pazzia" (Milano, 1878).

which assumed a confluent form. The disease followed its usual course, but during its progress the maniacal symptoms subsided. This continued with the disappearance of the eruption, and upon complete recovery from the attack of variola the patient was found to be restored to the full possession of his mental faculties and was discharged from the asylum. Fiessinger[95] reports a patient afflicted with acute myelitis when seized with variola. After recovering from the small-pox it was observed that the inflammation of the spinal cord had likewise disappeared. On the other hand, Stephen Mackenzie (quoted by J. W. Moore) has recorded a case of anterior poliomyelitis which followed variola.

Trousseau observed, in connection with severe lumbar pain during the initial stage of variola, a slight degree of paraplegia, which manifested itself by painful numbness and inability to move the lower extremities, while no impairment was observed in the arms and hands. The bladder is likewise sometimes involved, as shown by retention of urine or difficult micturition. These paraplegic symptoms are, however, of short duration, usually terminating with the eruptive stage. In rare instances, on the contrary, they have been known to continue until the tenth day, and more rarely through the whole attack.

Arnaud[96] has observed impairment of speech following an attack of variola, while Combemale[97] has collected ten cases of peripheral neuritis following variola, all of which manifested, for the most part, difficulty in speaking. In one case—that of a girl aged twenty, suffering from small-pox, which was accompanied by marked delirium and high temperature—it was noted on the fifth day that her speech was affected. There was a perceptible slowness in articulation, and her voice was somewhat nasal in character. The uvula deviated to the left and was insensitive. Difficulty was likewise experienced in framing answers to questions, and the labials and dentals were badly pronounced. On the twenty-fifth day the impairment of speech still persisted, and the left upper lid was observed to droop. Recovery finally took place at the end of two or three months. This observer refers to two other cases reported by Saint-Philippe, in which impairment of speech occurred quite early in the disease, or during the stage of infection. In both cases there was difficulty in swallowing, and in one paraplegia was

[95] Fiessinger: "La myélite algue curable dans la Variole." Méd. Mod. (Paris, 1898), ix, p. 341.

[96] Arnaud: "Troubles de la Parole consécutifs à la Variole." Marseille Méd., 1896, xxxiii, pp. 129-140.

[97] Combemale: Archives gén. de Méd., June, 1892.

marked. The patients finally made a complete recovery. Whipham and Meyers[98] report two cases, both in women about forty years of age, in which impairment of speech was observed during the eruptive stage, together with loss of power in the extremities. These patients recovered only incompletely from the speech affection after six and four years, respectively. Combemale thinks that the first three cases were of the nature of paralysis and that the last two were ataxic in character. According to this investigator, paralytic disturbances of speech are common, while verbal ataxia is rare. He believes the latter to be due to a persistent lesion of the nerve-centres, as from a slight hæmorrhage, while the paralysis he attributes to the effect of toxins upon the peripheral nerves. Combemale has further noticed that many patients speak with a nasal twang during convalescence from variola.

Hughlings Jackson[99] regards many of these neurotic disturbances as due to thrombosis in the minute vessels of the medulla oblongata.

Westphal[100] has recorded cases of small-pox in which there was marked paralysis of the lower extremities and bladder, which he believes due to numerous circumscribed foci in the gray and white matter of the spinal cord (myelitis disseminata). Charcot has observed a case of muscular atrophy of the arm consecutive to an attack of small-pox.[101]

Sottas[102] records the case of a youth, aged eighteen, who contracted variola, which, although it assumed a discrete form, was accompanied by unusually severe nervous symptoms, which led his medical attendant to fear meningitis. Gradually the patient became semicomatose and generally paralyzed. His speech was slow and dragging rather than scanning. There was slight nystagmus without tremor of the head, together with atrophy of the muscles of the trunk and limbs, with great diminution of muscular power. These paralytic symptoms gradually disappeared and were replaced by those of contracture. The reflexes became exaggerated, with inco-ordination of voluntary movement. Nine months later he presented a typical picture of disseminated sclerosis. He further remarks that at this time there were no atrophic disturbances of the skin, while his general intelligence suffered and he was excitable, impatient, and subject to violent fits of rage. Sottas

[98] Whipham and Meyers: The London Lancet, March 20, 1886, p. 562.

[99] Jackson (Hughlings), quoted by J. W. Moore (*loc. cit.*, p. 439).

[100] Westphal: "Ueber Nerven affectionen nach Pocken," Berliner klin. Woch., 1872, No. 1; also "Ueber eine Rückenmarkserkrankheit bei Paraplegie nach Pocken," *ibid.*, No. 47.

[101] Charcot: "Amyotrophie du membre supérieur droit, consécutive à la Variole, chez un fellah," N. incog. de la Salpêtrière (Paris, 1898), xi, p. 57.

[102] Sottas: Gaz. des Hôp., April 12, 1892, pp. 405 *et seq.*

records the case as a typical example of disseminated sclerosis of infectious origin.

The lymphatics are not infrequently the seat of disturbances as a sequela to small-pox. These are usually of a mild nature, although Hulke[103] has observed a case in which there existed a diffuse, radicular lymphangiectasis and lymphoma after a lymphatic abscess which he attributes to an attack of variola.

Affections of the joints are likewise sometimes, though rarely, observed. They are usually seen in strumous subjects, when they may prove a tedious, if not serious, sequela.

The Internal Viscera.—Arnaud[104] has recently given an admirable report based on a careful study of the various diseases of the internal viscera following variola. Béraud[105] has likewise given in detail a report of inflammatory affections of the *testicle*, and its analogue, the *ovary*. Although almost every organ of the body has been known to become affected by the small-pox process to a greater or less extent, there is nothing especially distinctive which calls for further consideration at this time.

PATHOLOGY.

Skin.—The epidemic of variola which began in the city of Cleveland in the winter of 1898-99 gave excellent opportunities for careful histological examination of the cutaneous lesions in their various stages, while a number of co-existent cases of varicella supplied valuable material for comparison of the two diseases.

The material was examined by Dr. R. G. Perkins of the Pathological Laboratory of Lakeside Hospital. It was taken during life, and placed at once in hardening fluid, thus preventing, so far as possible, any cell-changes previous to microscopical examination. The excised pocks were hardened, some in Zenker's fluid and some in a saturated solution of corrosive sublimate, followed by a succession of alcohols of strengths increasing from 70 per cent. to absolute. Sections were stained with eosin and Unna's polychrome methylene-blue after the usual methods.

The study of these cases was carried on through the whole epidemic, and involved examination of the pock in all stages, from its macroscopical inception to the final separation of the scab.

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[103] Hulke: London Lancet, 1893, I, p. 298.

[104] Arnaud: "Lésions viscérales de la variole," Marseille Méd., 1898, xxv, pp. 554-558.

[105] Béraud: Archives gén. de Méd., 1859, Nos. 3 and 5.

Clinically, as previously shown, the course of the pock is divided into papule, vesicle, pustule, and the formation and separation of the scab; *histologically,* these processes run into each other more or less gradually, and it is the *height* of each stage, and not its beginning, that gives the clinical name.

The seat of the lesion, from first to last, is in the stratum mucosum, and the first cell-changes occur just below the stratum corneum. From this point the cell-degeneration proceeds laterally and vertically, but more rapidly in the former direction, so that a section made vertical to the skin surface somewhat resembles a mushroom. Ordinarily the stratum corneum is not involved in the process, but where it is of unusual thickness, as on the palms and soles, the cell-changes are almost confined to it.

The cell-changes in variola and varicella alike are both preceded and accompanied by an œdema, both intercellular and intracellular, which varies in type according to the situation and relations of the cells involved. It is this *localized* œdema, previous to any cell-destruction, which gives the characteristic shot-like hardness to the papule. With the progress of cell-degeneration and change the papular stage passes over insensibly into the vesicular. It is at this period, before the picture is obscured by the invasion of polymorphonuclear leucocytes, that the finer changes in the pock can best be observed. The variation in type of the changes in the cells apparently depends on the thickness and relative resistance of the cell-walls, which characters are, in turn, dependent on the age of the cells themselves. Those nearest the surface are older, in process of preparation for the stratum corneum, and have, in consequence, a more resistant wall than the younger cells in the deeper parts. In general, there are, then, two types of cell-degeneration to be seen, both of which, as appears more in detail below, belong to the general class of fibrinoid degeneration.

In the more superficial cells the protoplasm liquefies, either in part or as a whole, leaving a finely granular albuminous precipitate. The cell-wall and the nucleus are both unchanged at this stage, the latter lying either against the side of the cell or being suspended in its midst by fine threads. But as the degeneration progresses the nucleus gradually loses its sharp stain and takes on a faint fibrin-stain. Increase of pressure leads in many cases to rupture of the cell-wall and the consequent extrusion of the nucleus into the dilated nutrient canals.

On the other hand, the change in the deeper cells is of a different type; the entire cell becomes opaque, there is practically no differentia-

tion between cell-body and cell-wall, and the consistency of the cell as a whole is diminished, as may be seen by the irregular forms it takes. The protoplasm not infrequently takes a fibrinoid stain, though individual cells or small cell-groups may be found in which the protoplasm takes a very bright eosin stain. The nuclear changes in this type are also very characteristic. The nucleus divides into fragments, from two to four in variola, but as many as twenty in varicella. When there is doubt as to the character of the fragments they may be distinguished, according to Unna,[106] from the nuclei of wandering cells by differential stains.

During the process of the pocks the exudate varies greatly in amount and character. At first it consists of serum only, but as early as the third day one finds plasma-cells of all types in increasing numbers. Such early invasion of plasma-cells is unknown in other processes, and is probably to be ascribed to the unusual virulence of the contagium. A few round cells and occasional mast-cells are also seen at this stage, but no polymorphonuclear leucocytes.

Consequent on this increasing intercellular exudation there is a tendency to increased elevation of the surface, and a general giving way in the direction of least resistance, as there has been no actual loss of tissue. In the deeper layers there is but little dilatation of the channels, but nearer the surface, where the cells are liquefied, the walls are ruptured, and the cell-remnants, some still containing pale nuclei, are pushed together in septa, which divide the vesicle into innumerable microscopical pockets, connected by small channels. This division and subdivision gives rise to the well-known clinical feature differentiating variola from varicella, namely: the extreme difficulty of evacuation of the variola pock, while the varicella pock, being practically a single vesicle, is easily emptied.

The cause of the umbilication characteristic at this stage has been a fertile source of discussion, and a variety of explanations has been offered. It is, of course, clear that when the pock lies about a hair the close adhesion of the surface epithelium to the hair stalk may prevent equal expansion of the surface, and can thus cause a central depression. But, in those cases in which there is no hair in association with the lesion, another cause must be sought. The relative amounts of the two forms of epithelial degeneration vary in different pocks. In

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[106] Unna (P. G.): Orth's "Lehrbuch der Spec. Path." (Berlin, 1894), vol. ii, pp. 639 *et seq.*

some the central portion is almost entirely taken up by the simple swelling without liquefaction, while the edges show the liquefying form, and are consequently more raised. In other cases the degeneration at the centre appears to be slower than at the periphery, with the same result. The strands or septa are of no consequence in this process, as is shown by the ease with which they give way when the pock becomes completely distended with pus.

The vesicular stage continues from the second or third day to the fifth or sixth, when the character of the exudate changes so markedly as to give its name to the third, or pustular, stage. Up to this point there has been no widening of blood-vessels; on the contrary, they appeared small and scarcely noticeable; but now they dilate, and a progressive infiltration with polymorphonuclear leucocytes begins, filling out the pock and breaking down the septa, until by the eighth or ninth day sections show an almost solid mass of pus-cells. Extensive nuclear fragmentation takes place, affecting the nuclei of the invading cells and plasma-cells, as well as the already partly degenerated epithelium.

This is the acme of the pock. From this time on the changes are regenerative in type. About the tenth day the pustule begins to dry up, either by a resorption of the more fluid elements or by a breaking through of the stratum corneum and consequent escape of the pus. In either case a crust is formed, composed of all the tissues which have undergone degeneration as well as the remains of the exudate. This crust is slowly pushed off by new growth of cells from all sides, comparable to the closing of an iris-diaphragm. A new stratum corneum is formed beneath the crust; so that, when this last finally falls off, the skin beneath is complete.

There is ordinarily no increased destruction of tissue during the pustular stage, but scratching or secondary infection may lead to a prolonged flow of pus, and consequently to increase of the depth of the wound. The degree of scarring depends on the destruction of the papillæ. In mild cases these are only moderately infiltrated, and may recover to a great degree, but in more virulent cases they become extensively infiltrated and necrotic, and are partly cast off with the crust. The new epithelium fails to fill up the defect, and consequently a depression is left.

For some time the vessels remain dilated, and there is an excess of pigment present in the skin. As mentioned previously, there is a distinct variation in the character of the epithelial changes in those areas

where the stratum corneum is much thickened, as on the palms and soles.

The epithelial changes have been a fertile source of discussions for many years, and no article can lay claim to completeness without some discussion of their relative merits.

A number of writers, among whom Weigert[107] is most conspicuous, consider them as coming under the head of "coagulation-necrosis." Against this idea is the fact that the nuclei are the last portions of the cell to be affected, and that necrosis *en masse* is not observed. Nor does the "cloudy swelling" of Renaut[108] give a sufficient description. The term is a very general one, in the first place; and, in the second place, does not describe the liquefying degeneration at all. This author, furthermore, describes a "cement-substance" between the individual cells, which he considers their support; but so far as the writer has observed, there have been no confirmations of this statement. Leloir[109] describes the whole process as *alteration cavitaire*; but though this term, which he further defines as liquefaction beginning about the nucleus and spreading by degrees throughout the cell, is a fair description of the changes nearer the surface, he apparently takes no account of the deeper changes, where there is no liquefaction, but the change takes place as a whole. Diphtheritic and croupous changes have also been described by Weigert and Leloir, but neither of these came under observation in the present series. Unna (*loc. cit.*, p. 639), whose work on the variola pock is probably the most exhaustive yet published, has endeavored to distinguish the two chief types of the epithelial degeneration by the names of "reticulating colliquation," which applies to the changes nearer the surface, and "ballooning colliquation," applied to the deeper changes, where he considers the swollen cells with fragmented nuclei to resemble small balloons.

The earliest statements as to the relation of the vessel-changes to the character of the exudate, especially as regards the primary anæmia, are found in the work of Renaut and Pincus.[110]

Renaut considers this as a spastic œdema, with an ectasia of the lymph-channels, while Pincus ascribes it directly to the infection. While there is room for further investigation into this matter, it seems that the latter view is right in the majority of cases.

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[107] **Weigert (C.)**: Archiv f. Path. Anat., vol. lxix, p. 409.
[108] **Renaut (J.)**: Ann. de Derm. et de Syph., 1881, ii S., ii, p. 1.
[109] **Leloir.** See Unna (*loc. cit.*, p. 645).
[110] **Pincus.** See Unna (*loc. cit.*).

Careful examination of the sections with approved bacterial stains fails to demonstrate any bacteria at any stage previous to the rupture of the stratum corneum. After this it is not uncommon to find cocci and streptococci in abundance, but only in the crust, not in the epithelium. The figures in the epithelial cells usually in the immediate vicinity of the nucleus have been discussed exhaustively by writers in all countries.

Guarnieri,[111] Pfeiffer,[112] Clarke,[113] and many others, put them in the class of protozoan parasites, though they have reached no definite agreement as to finer classification. To the present writer the work of Hückel,[114] who has made an exceedingly careful study of the subject, with an unusual wealth of experimental material, seems to be conclusive. In his general summary he says: "My results are both negative and positive: negative as far as they fail to explain the natural manner of the contagium; positive in so far as they show that in inoculations of the cornea with vaccine there is at the point of inoculation a certain portion of the cell-body of the epithelium which is affected in a definite manner. The characteristic pictures thus caused, due to as yet unknown structural properties of the cytoplasm, are direct results of these properties, and are not the parasitic protozoa of vaccine, as they have been described. It is not essential that the contagium should develop in the epithelial cell itself to explain the occurrence of the vaccine bodies. The cause may very well lie solely in the action of a toxin resulting from a contagium which occurs and increases extracellularly. Yet it must be admitted as possible that the contagium—over whose general and local action we are, indeed, informed, but whose nature and morphology is as yet entirely unknown—contained in the epithelium cells themselves and especially in the vaccine bodies, though doubtful as to development and increase, may be directly bound to the protoplasm. Perhaps the contagium is so minute that its perception with the existing optical facilities and microscopical and cultural methods may be impossible."

In this connection the recent work of Roux and Nocard[115] is of the greatest interest. They were unable to cultivate or even see the organism which they suspected to be the cause of pleuro-pneumonia in cattle, until they made use of the technique introduced by Metchni-

[111] Guarnieri (G.): Archiv. per la Scienze Med., 1892, xvi, pp. 40 *et seq.*
[112] Pfeiffer (L.): Monats. f. Prak. Derm., 1887, vi, p. 589.
[113] Clarke (J. J.): Cent. f. Bact. u. Parasit., 1895, vol. xviii, p. 300.
[114] Hückel: Ziegler's Beiträge, 1898, II Supplement.
[115] Roux and Nocard: Ann. de l'Inst. Pasteur, April, 1898.

koff.[116] Thin-walled sterile sacs of collodion were made, filled with a few cubic centimetres of bouillon, inoculated with the suspected fluid, which was taken with full precautions against contamination, and these sacs were placed in the peritoneal cavities of rabbits, guinea-pigs, calves, etc. The collodion prevented entrance of cells or exit of bacteria, but acted as an osmotic membrane, enabling the fluids within and without to freely interchange. The results were most satisfactory and showed the presence of organisms in inoculated sacs, which did not occur in the sterile control sacs. Again, these organisms were so excessively minute that a magnification of two thousand diameters was necessary to see them at all, and even with this power their form could not be made out. Copeman,[117] in his search after the organism of vaccine, inoculated eggs, which he kept in the thermostat for varying lengths of time, and claims to have found in them a small bacillus which would not grow on ordinary media. But his experiments were not sufficiently complete to establish either the impossibility of contamination or the identity of his organism with the contagium of vaccine. More recently K. Nakanishi[118] has isolated and studied a bacillus, which he finds constantly present in the vaccine pustules of children and calves, and to which he has given the name *bacillus variabilis lymphæ vaccinalis.* Biologically this organism shows a great variation in form and size, and is classified by Nakanishi as belonging to the group diphtheriæ or pseudodiphtheria bacilli.

Morphologically five chief forms may be distinguished. Intraperitoneal injections of bouillon cultures proved fatal in three rabbits out of five, with a moderate hæmorrhagic exudate into the abdominal cavity; but the most interesting changes were seen in those rabbits inoculated upon the cornea. In these cases, following a moderately deep inoculation, there developed corneal epithelial cells, which contained in their protoplasm, in the neighborhood of the nucleus, one to three round, or rod-like, bodies of various size, which appeared identical with the cytorryctes variolæ of Guarnieri.[119] While not affirming positively, in the absence of definite proof, the etiological relationship of this bacillus variabilis lymphæ vaccinalis, Nakanishi believes that it is the causative factor in vaccinia and variola.

In this connection it is interesting to note that Levy and Finkler,[120]

[116] Metchnikoff (E.): Ann. de l'Inst. Pasteur, 1899, xi, p. 245.
[117] Copeman (S. M.): The Lancet, 1895, p. 370.
[118] Nakanishi (K.): Cent. f. Bact. u. Parasit. u. Infect., 1900, vol. xxvii, May 26th.
[119] Guarnieri (G.): *Loc. cit.*
[120] Levy and Finkler: Deutsche med. Woch., June 28, 1900.

working independently, have isolated a bacillus called by them *corynebacterium lymphæ vaccinalis*, which is apparently identical with the bacillus described by Nakanishi. In conclusion they say: "Morphologically and culturally our bacillus belongs to the diphtheria-bacillus group, or more correctly to that group designated as 'pseudodiphtheria.' We have assigned it, on account of its branching, club-shaped, and round forms, to the great group of the actinomycetes, and more specifically to the genus corynebacterium of Lehman and Neumann." The etiological significance of this bacillus remains an open question. These experiments give hope that in the future, provided that such organisms are not beyond the power of human vision, we may find the character of the contagium of variola, as well as that of many other infectious diseases hitherto undiscovered.

Mucous Membranes.—After death the mucous membranes are found involved to a less degree than the skin. Those which are most exposed to the external air at the various orifices of the body, as has been previously shown, seldom escape, and often present well-defined variola lesions, while the general mucosæ of the respiratory and digestive tracts may show no traces of infection, even when the integument is thickly studded with pocks. An autopsy made at the Cleveland Small-pox Hospital showed the mucosæ entirely free, although fully a third of the cutaneous surface was covered with small-pox lesions. At other times there are only evidences of congestion in various parts, while, in some, what appears to be secondary pus-infection giving rise to diffuse or circumscribed purulent infiltration of the mucosæ may be detected. Curschmann describes catarrhal, croupous, or diphtheritic inflammation and diffuse purulent infiltration of the middle epithelial layer.

It may be stated as a rule that the changes in the mucous membranes are in direct relation to the extent and intensity of the cutaneous lesions. In confluent small-pox pustules are frequently found in the trachea as far as its bifurcation, and Wagner has seen them in the second and third branches of the bronchial tubes. In the hæmorrhagic forms there are likewise marked evidences of congestion, and yellowish exudation, with an abundance of bloody mucus, is seen. When death takes place late in the course of variola, terminal pneumonia and acute pulmonary tuberculosis are not infrequently found. Similar changes are often observed in the gastro-intestinal tract. Pustules may be found in the upper portion of the trachea and in the lower part of the rectum, with catarrhal inflammation and small hæmorrhages in the stomach and intestines. Sometimes the mesenteric glands swell and the intes-

tinal follicles suppurate. This may be mistaken for true variola pustules, which are occasionally observed. I am not aware that pustules have ever been found in the bladder, and the urethra seems likewise to enjoy complete immunity. There are evidences, even during life, of congestion of the urinary tract, and pustules sometimes occur at the meatus urinarius.

Serous membranes, according to my observation, are even less prone to become implicated than the mucous surfaces. In hæmorrhagic small-pox, ecchymoses and extensive hæmorrhages are found both in the mucous and serous membranes, as well as in the stomach and in the loose connective tissue of the thoracic and abdominal cavities.

The morbid anatomy of the internal viscera has been studied by Ponfick, Osler, Siderey, Laure, and others.

Internal Viscera. — The morbid changes have principally been found in the liver, spleen, and kidneys. The period at which death takes place, rather than the form of variola present, accounts for the differences noted. In hæmorrhagic variola, however, especially the purpuric variety, the viscera are found engorged with blood and otherwise but little changed, on account of the rapid termination of the disease.

When death occurs later, as in variola vera, the liver and kidneys are swollen and present granular or fatty degeneration, sometimes resembling that produced by phosphorus poisoning. The contents of the gall-bladder are usually pale and thinner than normal bile.

During the early stages of variola vera Ponfick[121] has observed the spleen greatly enlarged and its parenchyma soft and of a light color, while in purpuric variola it is small and of a dirty or dark-red color, with large white or yellowish follicles. Later in variola vera the spleen not infrequently appears unchanged. When the fatty degeneration of the liver and kidneys is far advanced, the heart-walls are yellow, flabby, and brittle. In purpuric variola, on the contrary, the heart has been found to be contracted, firm, and brownish red. The brain and spinal cord are usually but little changed, although they may be congested and œdematous.

The Blood.—In hæmorrhagic small-pox it was formerly supposed that the bleeding occurred from an infective dissolution of the blood, or hæmatolysis. Klebs[122] and Unna (*loc. cit.*), however, explain the hæmorrhagic process as one of bacterial thrombosis in which the blood-channels of the skin, in common with other organs, are blocked with

[121] Ponfick (E.): Berliner klin. Woch., 1872, No. 42.

[122] Klebs (E.): Handbuch der Path. Anat. (Berlin, 1868-80), v. I, p. 40.

bacteria, causing coagulation and consequent diapedesis into the surrounding parts. The pathological difference between the purpuric and hæmorrhagic varieties is one of degree only. In the former diapedesis, or acute hæmatophilia, is established at the onset and death takes place during the initial stage, while in the latter it occurs during the development and maturation of the pustules.

After death the dark-purple spots and extensive ecchymoses remain unchanged.

According to Weil,[123] variola is generally accompanied by leucocytosis, which is a mononucleosis of large granulated or non-granulated myelocytes: the mother-cells of the normal leucocytes in the blood. This type of leucocytosis has been noted in myelogenic leukæmia alone, and it shows an interesting analogy between leukæmia and variola, which also affects the bone-marrow. Nucleated red corpuscles may also appear in the circulation; they are constant in the hæmorrhagic forms, with 1 normoblast to 100 leucocytes, and possibly 25 per cent. of neutrophile mononucleated cells. The pus of the pustules contains the same variety of leucocytes found in the blood, and consequently the suppuration is evidently an integral part of the variolar infection. The differentiation of variola is possible at an early stage by the study of the blood; the only eruptive disease resembling it is varicella, in which a mononucleosis, though in less degree, also occurs.

ETIOLOGY.

Following the prevailing trend of pathology in various epochs of medical history, small-pox has been ascribed to various influences. At one time it was supposed to be due to emanations from decomposing matter, again to special climatic conditions. With the advent of organic chemistry and its important revelations early in the nineteenth century, it was fully expected that the *causa causans* of variola would be revealed. We of the present day believe that with the future development of bacteriology the etiology of small-pox, together with other infectious diseases, will, in the near future, be made clear. We have elsewhere shown that the disease is well-nigh co-existent historically, with the human race, and is encountered over the entire globe. Neither climate, soil, nor race seems to influence its spread, and, like many other infectious diseases, its first appearance among primitive peoples is marked by great severity.

Season of the Year.—This has a marked influence on the develop-

[123] Weil (E.): Presse Méd., June 27, 1900.

ment of variola. In the United States, Canada, and Europe small-pox is more prevalent during the late autumn, winter, and early spring months, while during the summer it usually occurs only in sporadic cases, if at all.

In the general epidemic of 1898-1901, as observed in Ohio, the disease began with a few sporadic cases during the summer, and as cold weather set in it spread more or less generally throughout the State. During the cold months the disease gradually extended and did not entirely disappear until the summer had well advanced. During the past eighteen years cases of small-pox in the city of Cleveland have been extremely rare during the summer months, and no epidemics have occurred at this time, while during the winter months small-pox epidemics of more or less severity have occurred at frequent intervals. In tropical countries, where small-pox is more prevalent at the present time than in the temperate zone, the opposite holds true, the disease being more prevalent during the hot weather and ameliorated by heavy rain-falls or during the months of a tropical winter. Opinions differ as to whether the deficient ventilation occasioned by cold weather is responsible for this increased prevalence. At any rate, it is highly probable that ill-ventilated apartments tend to increase the danger of infection. It has been shown by J. W. Moore (*loc. cit.*) that in northern Europe the disease thrives best when the temperature is below 50° F. This, according to my observation, likewise holds good in North America.

Age.—Before the introduction of vaccination, small-pox, like scarlet fever and measles, was essentially a disease of childhood. Being susceptible, the child generally contracted the disease at an early age, which conferred immunity against a second attack for the rest of life. When the disease first appears in a country, however, all ages are equally attacked. Since the introduction of vaccination the proportion of adults who contract small-pox is greater than that of children, because children are usually vaccinated, thus affording immunity for a number of years. Revaccination is less generally performed, which renders a greater number of people susceptible to the disease in adult life. Of 763 cases of small-pox reported to the Ohio State Board of Health during the winter of 1898-99, 66 per cent. were in adults. Statistics show that previous to the end of the eighteenth century small-pox was largely a disease of children. A moment's thought will show that this must be so in any disease so contagious as small-pox; most children being liable to it, and unprotected, contract it at an early age, whereas most adults

have had a certain degree of immunity conferred by an attack of small-pox in childhood.

In Chester, England, for instance, in the spring of 1774, 202 deaths occurred from small-pox, all of the patients being under 10 years of age and a quarter of them being under 1 year. In Kilmarnock, of 622 deaths which occurred between 1728 and 1763, only 7 were of patients above 10 years of age; and in Edinburgh between the years of 1764 and 1783, 993 out of every 1000 who died of small-pox were under 10 years of age. Statistics show clearly that this record of the eighteenth century is reversed under compulsory vaccination laws. Children very generally escape, adults furnishing much the larger proportion of cases attacked. The inference is unavoidable that revaccination is almost as urgently needed as is the vaccination of children. According to some writers, infants at the breast are less susceptible than those of a year or more of age. This, however, I have been unable to confirm. The disease, moreover, occurs in intra-uterine life, as has been frequently observed. Curschmann found evidences of a small-pox eruption in a fœtus of five months, and in one instance I have observed what appeared to be a variolous eruption in a fœtus between the fourth and fifth month whose mother was afflicted with variola.

Sex has no appreciable influence, although in the reports of the Metropolitan Asylum of London males are slightly in excess. This, doubtless, arises from greater exposure, their vocations bringing men in contact with the small-pox contagium more frequently than women, who remain more at home.

Pregnancy does not predispose to the disease, neither does the general state of health appear to exert any influence. On the contrary, strong adults seem to furnish a large contingent of small-pox patients.

Race.—It is generally believed that the African race is more susceptible to small-pox than the European, and that the dark-skinned are more susceptible than the Caucasian. From personal observation I am inclined to attribute this to the unhygienic surroundings of the African more than to any racial predisposition *per se*. Neither have I been able to observe any marked severity in those attacked. The native Indians of America are especially prone to the disease. From its first introduction by the Spaniards to the present time, whole communities and tribes of Indians have been completely obliterated by its invasion. With them it seems to thrive with the thermometer 40° F. below zero as readily as in the tropics. Again, their mode of living favors, in a high degree, the spread of infectious diseases when introduced among

them. All persons do not manifest in an equal degree a predisposition to variola nor is the same person equally susceptible at all times. Numerous instances are recorded in which small-pox finally developed months after repeated exposure to the disease had occurred.

Association with Other Diseases.—The frequent occurrence of the prodromal rash in variola and its close resemblance to the other exanthematous affections has doubtless given rise to the belief that small-pox not infrequently is accompanied by either scarlatina or measles. Curschmann, whose extensive observations have enabled him to contribute most exhaustively on this subject, says: "In the hospital at Mayence convalescents from typhoid fever sometimes contracted small-pox from the adjoining small-pox ward, and rarely small-pox has followed convalescence from other exanthematous affections, but it is extremely doubtful if, during the height of these diseases, small-pox can be contracted." MacCombie[124] in his extensive experience with small-pox has not seen a single instance of the co-existence of small-pox with any of the acute infective eruptive diseases. I have never encountered variola in connection with the other exanthemata, although it has been observed to occur in connection with syphilis, acne, eczema, psoriasis, and other affections of the skin. Variola in syphilis has, in my observation, always pursued a mild course, although I am not prepared to attribute any protective influence to this condition, as in every case the patient claimed to have been previously vaccinated. In one instance, that of a negro, who entered the hospital with secondary syphilis, there seemed to be complete immunity to small-pox infection, until some months after entering he was inoculated by an attendant, which in due time gave rise to a mild attack of variola.

Mode of Infection.—Although, as previously shown, the contagious nature of variola had been recognized at a very early period, to Boerhaave,[125] of Leyden, we are indebted for a clearer description of the disease and its mode of propagation than had heretofore been given. The present state of our knowledge justifies us in assuming from analogy that the active principle in causing small-pox is a micro-organism which exists in the vesicles, pustules, crusts, and is probably carried off by currents of air; so that infection may take place at some distance from the body. Inoculations of blood, urine, and saliva from small-pox pa-

[124] MacCombie (J.): "Small-pox" in "Allbutt's System of Medicine" (New York, 1897), vol. iii, p. 212.

[125] Van Swelten: "Commentaria in H. Boerhaave Aphorismos," tome v, Lugd. Bat. 1772.

tients have been made with a negative result, although these investigations cannot be regarded as conclusive. On the contrary, it is highly probable that the blood of small-pox patients contains the virus in a high degree. The usual mode of infection is directly from person to person, although mediate infection from a third person, or from clothing, infected rooms, bedding, books, rags, etc., is not infrequent. It has been found that even during the prodromal stage infection is possible,[126] although it is during the eruptive stage that the disease is usually communicated. The period of greatest danger from direct exposure is during the pustular and desquamative stages. At this time entering the room is sufficient to communicate the disease. The size of the room and the number of patients therein naturally determine the danger of infection. Likewise, increasing the distance from the focus of infection lessens the danger of infection. A patient is not to be considered free from danger until all crusts and scales have disappeared, when, after thorough cleansing of the body and disinfection of the clothing, he may be considered inocuous. The virus retains its contagious property for a long, though indefinite, time. According to Buck,[127] undoubted instances are recorded of the virus remaining active from one to two years. Excluding a free circulation of air favors this maintenance, while it is extremely doubtful if the virus remains active when suspended for a short time in the open air.

The aërial distribution of small-pox has of late received much attention. Some—with Power,[128] Barry,[129] and Evans[130]—have endeavored to prove that the infection of districts surrounding small-pox hospitals bears an inverse ratio to the distance from the focus of contamination; while Savill,[131] Seaton,[132] and others believe that aërial currents are not an appreciable factor in the diffusion of small-pox.

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[126] Schafer relates (Deutsche Militairärztl. Zeit., 1872, p. 53) an instance of transmission of small-pox during the latent stage. Skin from a recently-amputated arm was employed in the Charité Hospital of Berlin for transplantation on other individuals. At the time of amputation the patient appeared to be free from small-pox infection, but some hours later was seized with the premonitory symptoms of the disease, which was followed in due course by the small-pox eruption. Of those on whom the transplanted skin had been placed, one was attacked six days later with small-pox, while the others remained free.

[127] Buck (A. H.): "Treatise on Hygiene" (New York, 1879), vol. ii, p. 519.

[128] Power (W. H.): "Supplement to the Local Government Board's Annual Report" (London, 1880-81; also 1884-85-86).

[129] Barry (F. W.): "Report of an Epidemic of Small-pox at Sheffield, 1887-88" (London, 1889).

[130] Evans (A.): Brit. Med. Jour., 1894, ii, pp. 356-358.

[131] Savill (T. D.): Brit. Med. Jour., 1897, ii, p. 1680.

[132] Seaton (E.): Brit. Med. Jour., 1896, i, p. 582.

Barry found a noticeable increase in the number of dwellings infected which were situated within 4000 feet of a small-pox hospital. This he reduced to mathematical precision in the accompanying diagram. Similar observations are given by Evans in the epidemic of 1893 at Bradford. It was observed that, between January 14th and December 30th, 626 dwellings situated within a mile of the small-pox hospital

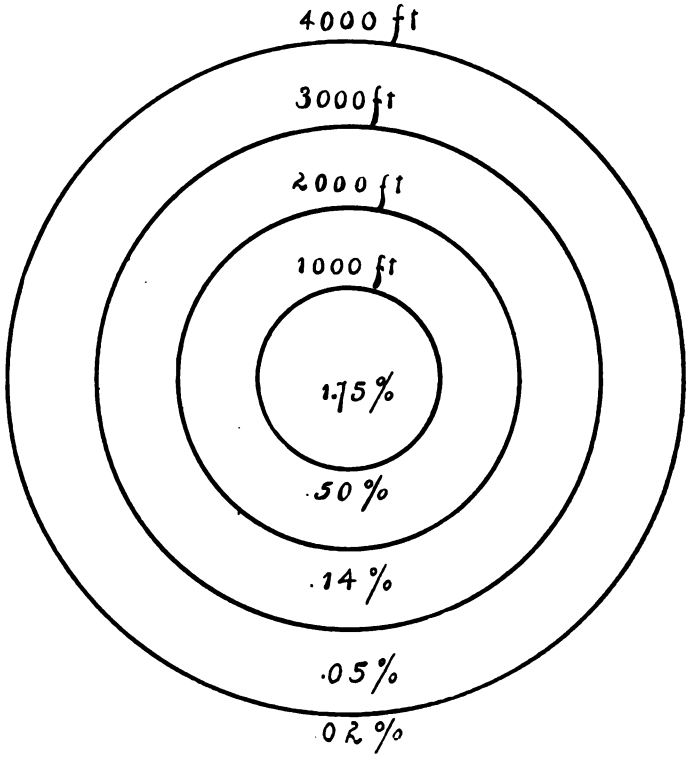

Diagram showing the Influence of the Sheffield Hospital in Spreading the Disease in 1887-88. (Taken from J. W. Moore.)

were invaded by the disease. The percentage for the whole borough outside the mile area was 0.6, while within the mile radius it was 3.6 per cent. He further estimated the percentage within a quarter-of-a-mile radius to be 10.4, between a quarter and a half mile, 6.8; between half and three-quarters of a mile, 2.1; and only 1.0 per cent. for houses situated between three-quarters and one mile from the hospital.

Aërial currents are likewise shown to influence the spread of the

disease in question. Thus, it was observed that a larger proportion of houses (7.06 per cent.) became newly invaded on the northeast side of the hospital, while the corresponding quadrant on the southwest side was affected least of all, showing a percentage of only 2.93 per cent., the prevailing winds being from the southwest. Savill, on the contrary,

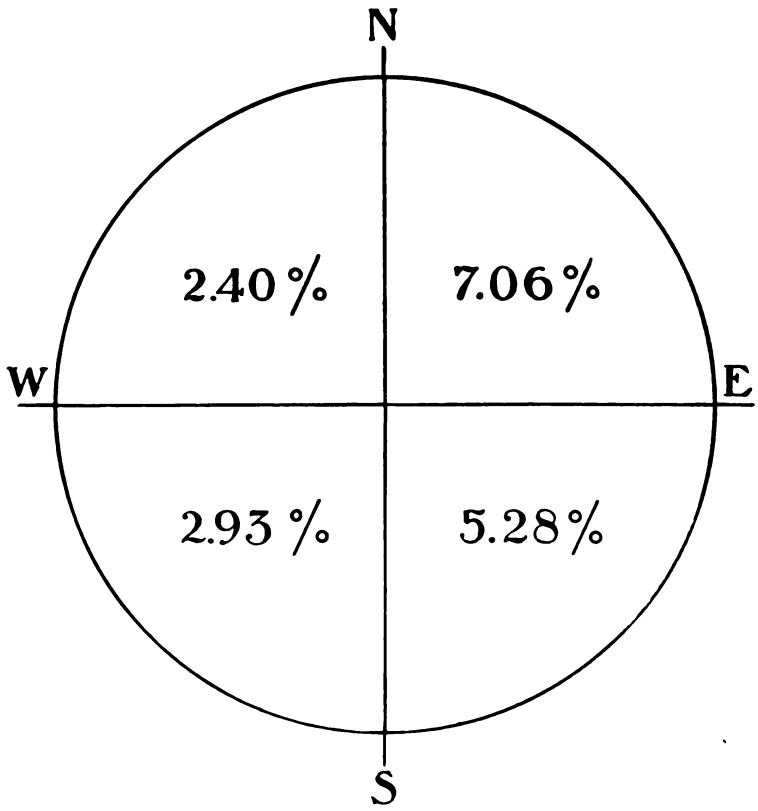

Diagram showing the Influence of Wind in Disseminating Small-pox.
(Taken from J. W. Moore.)

in observing the diffusion of small-pox in two buildings in which there were 1076 persons adjoining a small-pox hospital, ascertained that in 10 only was the source of infection other than direct exposure or contact. The epidemic continued nine months, and in concluding his observations he remarks that the air, being a bactericide in itself, he does not believe that the small-pox poison is infectious beyond the confines

of a room. Seaton quotes Billings to the effect that a collection of small-pox cases may be so managed as to prevent the diffusion of specifically-infected dust to surrounding dwellings, although in this country it is customary to locate small-pox hospitals away from thickly-populated districts. In Cleveland the Small-pox Hospital is situated about eight or nine miles from the city in a rather thickly settled farming community. The prevailing winds, which are from the west and northwest during the winter months, carry the dust from the small-pox hospital toward two dwellings situated less than half a mile from the hospital. For seven months the hospital was crowded, during which time observations were made, yet no instance of conveyance by the air was or has since been reported. With proper precautions against the accumulation of dust and other *débris*, it seems highly probable that the danger from aërial infection is but slight, and that dwellings situated a quarter of a mile or less from small-pox hospitals may be considered free from danger.

DIAGNOSIS.

In typical cases of small-pox little difficulty need be experienced in arriving at a correct diagnosis, the appearance of the disease being so striking and many of the symptoms so distinctive that when once seen they cannot well be mistaken. In former times the principal obstacle to diagnosis lay in the severity of the disease, while to-day the mild nature of the affection, as frequently encountered, gives rise to the main difficulties in its recognition.

During Sydenham's time the *black death* gathered in its countless thousands, even before the first distinguishing features of small-pox appeared. With the advent of vaccination, and possibly of better hygienic conditions, much of its old-time severity has passed away, although the problem of differential diagnosis still remains the *bête noire* of many practitioners.

The most important time to recognize the disease is at the onset, as it is at this time that uncertainties of diagnosis are most liable to occur. During the past three winters excellent opportunities to study small-pox have occurred in Cleveland. In observing cases entering the Small-pox Hospital one was impressed with the fact that in many instances the disease was well under way before the patient was received. Upon inquiry it was ascertained that in most cases an uncertain diagnosis had occasioned the delay. It is also an unfortunate fact that a mistaken kindness—a too tender regard for the feelings of the patient and his

immediate family—deterred medical men from reporting suspected cases. It is not strange, therefore, that, in spite of the efforts of the health department, the epidemic insidiously extended until its victims within a few months were numbered by the hundreds. Much controversy likewise arose as to the diagnosis of individual cases, because typical landmarks were sometimes wanting. Thus, it may be argued that the eruption is not one of variola because umbilication is not present; again, that the eruption does not develop in regular order from the shot-like indurations in the skin to vesicles, which remain from one to two days and go on to pustules which finally, as desiccation proceeds, form crusts; that the lesions are not met with on the palms of the hands or soles of the feet; or that the pocks collapse on puncturing with a needle; and finally that the whole process of development may occupy less than a week. These exceptional conditions prove extremely confusing, if we expect to find in all cases the regular order of symptoms as detailed under a typical case of variola vera. Yet all these exceptions may be encountered and still the case be one of small-pox.

How, then, are we to recognize the disease and differentiate it from other affections to which it bears a striking resemblance? After an extensive study of the affection covering a period of eighteen years, and embracing numerous epidemics in different countries where climatic conditions are greatly at variance, the writer has formulated the definition of varioloid, previously given, as the disease of exceptions. During the early part of an epidemic, or in sporadic cases, there are few physicians who may not be thrown off their guard and fail to recognize a mild form of variola. Especially is this the case when mild initial symptoms are followed by an eruptive stage in which but two or three lesions are present, as we have repeatedly observed at the Small-pox Hospital; or, when the eruption, likewise following the mild initial stage, goes through the various stages of development in quick succession, the whole process being completed within ten days or a fortnight. A case illustrating this point may be given in brief: During the early part of the epidemic of 1898-99 a young woman presented herself with an eruption which gave rise to a wide difference of opinion. It was of a mild type and the lesions were few and underwent rapid changes from papules to vesicles, which, in the course of a day or two, developed irregularly into pustules. These varied greatly in size, the majority being no larger than a lentil. They were most prominent on the trunk, where their transformation was the most rapid. On the sixth or seventh day desiccation took place, and the crusts dropped off

a few days later, leaving slightly-reddish, pigmented spots. No destruction of the skin took place. Acting on the diagnosis of the present writer, she was sent to the Small-pox Hospital, where she was again seen three days later. At this time the rapid changes that had taken place attracted my attention and led to further inquiry. It was ascertained that a sister, previously attacked, was suffering with confluent small-pox in the same ward, from whom fine photographs were secured from which Plates XI, XIII, XIV, and XVI were made. As neither of these patients had been previously vaccinated, and as it failed in the second case after the eruption appeared, it seemed evident that the disease was the same in each.

The second important feature to bear in mind is the character of the lesions themselves. The typical small-pox lesion is indurated. This feature appears early in the development of the pock, and is the last to disappear. In anomalous small-pox or varioloid there may be many cases in which induration cannot be detected. In fact, the most prominent lesions may be composed of small blisters containing either a clear serum or pus, which, when punctured, completely collapse, leaving no induration in the skin, and if the shriveled epidermic covering be removed by slight friction a small denuded area will result. This resembles what is seen in varicella, and lesions of this kind cannot be considered typical of variola. In all cases of variola, however, certain lesions will be found to present the indurated appearance previously described. Such lesions, when punctured, do not readily discharge their contents, several punctures being necessary to evacuate them. After this is done friction will not cause denudation, but the pock remains as an elevated, ragged lesion. When seen even after the crust has dropped off, the areas previously affected in the active small-pox process will be slightly elevated, with parchment-like induration.

The symptoms of small-pox during the initial stage often simulate CEREBRAL MENINGITIS more closely than any other disease. Again, from the severe epigastric pains accompanied by obstinate vomiting INTUSSUSCEPTION of the bowels has been mistaken for variola. Curschmann (*loc. cit.*) relates an instance in which a patient was sent to the hospital with what was supposed to be intussusception, which proved to be the initial stage of hæmorrhagic small-pox, which proceeded rapidly to a fatal termination. Recently a case came under the author's observation which was sent to the hospital with severe pain in the abdomen, in which the diagnosis of APPENDICITIS was made and an operation performed. Two days later an eruption of small-pox broke out.

This is not given as an instance of mistaken diagnosis, for a gangrenous appendix was found and the history of previous attacks led to its early recognition. At the same time it must be acknowledged that it is difficult to say how much of the disturbance complained of was due to the gangrenous appendix. The case is of importance, however, as it teaches the possibility of error, which, in such cases, one should ever bear in mind. At other times, from the severe gastric disturbances during the stage of invasion, the INGESTION of TOXIC SUBSTANCES has been suspected. Another instance of mistaken diagnosis resulted more seriously. A patient applied for admission to a hospital, and after being examined by the resident physician was admitted into the general ward with what was supposed to be TYPHOID FEVER, with the Widal reaction well marked. A few days later an eruption appeared which was attributed to the potassium iodide which the patient had taken (20 grains in the course of three or four days) for a slight bronchitis likewise present. It was not considered of sufficient importance on the part of the resident medical officer in charge to call special attention to it until six days after admission, when, on examination, the patient presented a typical eruption of small-pox in the pustular stage. The result may be imagined; fortunately, however, only two nurses and one patient occupying the next bed contracted the disease.

The erythematous rashes which so frequently accompany the first symptoms of variola have led to the belief that one had to do with a mixed infection, which most authorities regard as extremely rare. We will now consider *seriatim* the various affections with which small-pox is most likely to be confounded.

Measles.—A possibility of error between measles and small-pox can occur only during the initial stage and the beginning of the stage of eruption. With the initial fever of small-pox it has been shown that an erythematous eruption is not infrequently observed. When widely diffused and blotchy, it may be mistaken for measles, to which it often bears a close resemblance. In measles, however, the rash appears later, usually during the third or fourth day, and first shows itself as reddish macules on the face and upper part of the trunk, while these parts are the last to be involved in the prodromal rash of variola. Furthermore, the catarrhal symptoms which are so prominent in measles are absent, or nearly so, in small-pox. On the other hand, severe lumbar pains are seldom encountered in measles. There is less likelihood of error during the eruptive stage. In the confluent and more especially the hæmorrhagic form of variola, however, mistakes have been made. It should

be borne in mind that the lesions in measles are flat, soft, and velvety to the touch, and when put on the stretch show no perceptible thickening of the skin, while the early papules of small-pox are indurated, small, and feel like duckshot imbedded in the skin. In measles the blotches develop by peripheral extension until they spread out to dime-sized areas, while in small-pox the process of development is, though deeper, more circumscribed and seldom exceeds a split-pea in size. Vomiting is not an infrequent symptom in both diseases, although it is more constant in variola. In both diseases blotches may be detected in the fauces, although in measles the eruption is more distinctive, as will be shown, and appears fully twenty-four hours before the skin shows signs of implication. This, with the association of catarrhal symptoms, will enable one to determine the nature of the disease. With the appearance of the eruptive stage the temperature rapidly falls in variola, while no remission is observed in measles. The prevalence of an epidemic or of other cases in the immediate vicinity will sometimes facilitate in making a diagnosis, or at least put one on guard.

Scarlet Fever.—The prodromal rash of variola which counterfeits scarlatina is met with for the most part in mild cases, and is accompanied by little, if any, anginal symptoms. The premonitory symptoms are always severe in variola and of two or three days' duration, while in scarlet fever, on the contrary, they are of short duration, usually but a few hours, often slight and may be entirely overlooked. The pulse in the latter disease is rapid and out of proportion to the fever, while in variola the fever and pulse lines run nearly parallel. In scarlet fever the erythematous blush appears first on the upper part of the chest, cheeks, or neck. In variola the scarlatiniform rash is best marked on the lower part of the abdomen and inner surface of the thighs. On careful examination one may often distinguish between the two diseases from the rash alone. It is bright and fiery in scarlet fever and of a dull red in variola. Another distinguishing feature is the swelling of the lymphatic glands about the lower jaw, so common in scarlet fever and seldom, if ever, seen in an early stage of variola. The conspicuous papillæ, or strawberry tongue, so constant in scarlet fever, is also absent in variola. Finally the age of the patient is often of assistance. It should be borne in mind that the prodromal rashes of variola seldom occur in young children, while adults seldom suffer from scarlet fever.

Impetigo.—The differential diagnosis between small-pox and impetigo is sometimes a matter of some difficulty. In this connection it is of interest to note that the prevalence of supposed impetigo in several

towns in Ohio, during the autumn of 1898, gave rise to an undoubted epidemic of small-pox. During the past year, while making a series of observations on impetigo and its various forms, especially the bullous impetigo, or the pemphigus contagiosus, the subject of the differential diagnosis between small-pox and impetigo was again brought forcibly to mind. An interesting experience in this connection was related me by a colleague as follows: The case in question occurred on board the *Yale* on its way to Santiago, and upon the diagnosis depended the movement of the American forces during the late Spanish-American War. The patient causing the commotion among the army and navy medical authorities was a native of Connecticut who had been previously vaccinated, and to the best of his knowledge he had not been exposed to small-pox. Soon after embarking he was attacked with a bullous eruption, which extended over the entire body. It appeared without premonitory symptoms of any kind, and its presence did not affect the robust health of the patient. The bullæ developed until they attained a size varying from a pea to a pigeon's egg and ruptured easily, leaving excoriated surfaces and a desquamative *débris* of epidermis. The case was pronounced by the ship's surgeon to be one of small-pox. The weight of this diagnosis was enhanced by the fact that the surgeon had had much experience with small-pox, having observed it in various climes. A staff surgeon on board, who had charge of the brigade, was asked to see the case, and took occasion to differ from the opinion expressed, regarding it as a case of pemphigus. The patient, however, was suspended aloft, and an electric fan-device was placed under his cot to drive the contagium away from the other passengers. Arriving at Santiago the case was seen by the staff surgeon of the commanding general, who confirmed the diagnosis last named. The man was sent ashore, but the fort medical officer refused to admit him on the ground that it was a case of small-pox. At this time it is said some friction arose between the naval and land forces as to whether the fleet should be sent to harass the coast of Spain or continue their united efforts in Cuban waters. It was urged by the naval commander that the case, being one of small-pox, the *Yale* and its passengers would have to undergo the restrictions of quarantine; hence it would be impossible to follow out the plan proposed. Happily, the recovery of the patient relieved the difficulty, and thus was averted a mistake which might have changed the history of the war.

During a recent epidemic the present writer took occasion to study the various conditions bearing upon its differential diagnosis from im-

petigo, and in two instances found the similarity most striking. The first occurred during the early stage of the disease, with few lesions present. The second, of which an admirable photograph was obtained (Plate VII), illustrates the tendency late in the course of variola to assume a bullous character. This is best marked on the hands, and to a less extent on the feet. It usually occurs about the twelfth or fifteenth day of the disease, and is due to secondary infection by the ordinary pus-cocci, giving rise to a collection of serum under the epidermis surrounding the incrusted small-pox lesions. An intimate familiarity with the lesions in both diseases, however, would readily enable one to recognize either affection.

Chicken-pox.—Unquestionably many errors occur in determining between varicella and variola. In fact, in Germany, following the teachings of Hebra, maintained by Kaposi, the two diseases are looked upon by some as identical, while in England, France, and America they are regarded as entirely separate affections. The subject has been so ably discussed by others that I will not take time in pursuing it further, for it has been clearly demonstrated that the two diseases have nothing in common, save the somewhat similar appearance of the eruptions.

Mild cases of variola, it is true, closely simulate varicella, and even the experienced diagnostician may, for a time, hesitate between them. Investigations, previously detailed, have demonstrated that the lesions differ both in histological location and in the manner of their formation. Thus, the first changes in variola take place deeply in the stratum mucosum, while in varicella the superficial strata of the epidermis are principally involved, and a serous exudate, which is frequently the first symptom of the disease, occurs at this point, resulting in a transparent, thin-walled vesicle; while in variola the shot-like, deep-seated induration and subsequent vesicular formation are sufficiently distinctive to warrant a differential diagnosis. The lesions in varicella, as a consequence, are easily destroyed, and, when seen, present a transparent, beady appearance, some of which, having ruptured, leave excoriated areas; whereas in variola it is impossible to rupture the lesions so as to evacuate the entire contents without numerous punctures or by totally destroying the diseased area. But we must not lose sight of the fact that in varioloid many lesions may abort, producing a mixed eruption, in which vesicles indistinguishable from those of varicella may appear, and that the presence of pus-cocci often further masks their true nature. Again, as a rule, variola presents more uniformity of development, papules, succeeded by a whitened appearance, giving rise

to pustules, followed by desiccation, forming blackish crusts. In varicella, on the contrary, multiform lesions are the rule, macules, vesicles, and pustules, together with excoriated areas, being observed at the same time. This is due to successive crops of maculæ on the same region of the body, which are not observed to the same extent in variola. In the latter disease the eruption appears on the face, where it is usually most thickly distributed, while in varicella the trunk is usually first attacked and the parts covered by the clothing afford the usual seat of predilection. The duration and development of the lesions are likewise of importance. In varicella they are short-lived, an individual lesion seldom lasting more than a day or two; whereas in variola they go through a regular process of development and, excepting in abortive pocks, attain their maturity about the eighth day, after which desiccation and the formation of crusts follow. Usually a fortnight to three weeks completes the life-history of the lesions. In mild cases of variola, sometimes called spurious small-pox or varioloid, the time of development is shortened, and in these cases the greatest difficulty in diagnosis arises. But even here the multiform character is less conspicuous, as well as the successive crops of the eruption, and although the lesions may only last a week or even less, there will be found some which adhere to the type, and which, with close observation, may be recognized with certainty.

When called to a doubtful case, the following points should be carefully considered: The length of time since vaccination, and whether or not the patient has ever had chicken-pox. Small-pox is extremely seldom encountered within three or four years after vaccination, while after that time the number of cases of varioloid or abortive small-pox steadily increases. Chicken-pox, like small-pox, occurs but once in the same individual. Prodromal symptoms are always present for several days, usually three, in variola; absent or of a few hours' duration in varicella.

The temperature often renders valuable aid in differentiating between the two diseases. In variola it rises rapidly, and even in mild or abortive cases usually reaches 103° to 104° F. (39.4°-40.0° C.), when, on the appearance of the rash, a crisis takes place, and it falls to the normal within a few hours, where it may remain throughout the remainder of the disease. Varicella, on the contrary, is seldom ushered in with fever, but the temperature usually rises one or more degrees as the eruption develops. When the case is seen for the first time after the eruption has appeared, and, as often occurs, no definite

history can be obtained, other symptoms must be relied upon. The distribution of the eruption is usually of great diagnostic importance. In varicella the parts protected by the clothing, especially the back and chest, are mainly involved, while variola finds its special seat of predilection on the exposed parts, the face and hands, with a strong tendency to cluster about the nose and forehead. In varicella the lesions first appear as macules, never indurated as in small-pox, and in a few hours develop into prominent, transparent vesicles (see Plate XXVI). Umbilication is usually present at some period in the development of the small-pox lesion, while it is absent in varicella, the nearest approach to umbilication being the formation of a minute central crust as resolution sets in. As a rule, the lesions are of more uniform size in variola than in varicella, although this is by no means an infallible test. Until all doubt as to the diagnosis is removed, public safety demands that the worst be prepared for, consequently all cases should be treated as small-pox until it is definitely determined to the contrary.

Finally, the age of the patient is important; the writer has never encountered chicken-pox after puberty, and the consensus of opinion bears out the statement that it is essentially a disease of childhood.

Influenza. — During the presence of influenza, such as has occurred in various countries during the past few winters, most patients and not a few physicians frequently mistake the premonitory symptoms of small-pox for "an attack of *la grippe.*" When in due time an eruption appears, they, like the ancient Greeks, do not consider the exanthem of sufficient importance to determine the name of the infection; hence the neglect, in many instances, of the proper measures for limiting the spread of the disease. Reiteration is not necessary, for a careful consideration of the symptoms will remove any doubt that may at first exist. The importance of making daily visits in all suspected cases, especially during a small-pox epidemic, cannot be too strongly urged.

Syphilis.—The first patient sent to the Cleveland Small-pox Hospital after its completion was a negro suffering from syphilis. The appearance of eruptions both on the palms and soles often so prominent in small-pox as well as syphilis, sometimes renders their differentiation difficult. Adding to this the lesions on the mucous surfaces that occur in both diseases, the clinical picture may be doubly confusing. I recall a patient who once presented himself at the Middlesex Hospital, under Dr. Liveing, in whose case experienced men differed in opinion between these diseases. A careful study of the case,

however, will enable one to form a correct opinion as to its nature. The eruption on the palms and soles is always of diagnostic value, for, while it occurs in varicella to a very limited extent and is also present in syphilis, it never assumes the pustular character so prominent in the variolous eruption. That there is a distinguishing odor to variola I have never been able to confirm; an equally extensive suppuration of the skin from other causes, with like inattention to cleanliness, will, according to my observation, give rise to the same nauseating stench.

Drug Eruptions.—Not infrequently, during the prevalence of small-pox, suspected cases are observed at my clinic manifesting eruptions which, on further investigation, prove to have been caused by the ingestion of cubebs or copaiba. Potassium iodide also sometimes gives rise to a pustular eruption which at first sight may closely resemble that observed during the eruptive stage of variola. In these cases an accurate history of the previous condition is important. The absence of all febrile symptoms and the odor of the drug, which may frequently be detected, will usually enable one to arrive at a correct conclusion as to their nature.

Eczema.—It is only when called late in the course of the disease that the eruption of small-pox presents any resemblance to eczema. Such, however, has occurred (see Plate XXII). The family medical attendant, seeing the pustular mask on the face, regarded it as a severe case of pustular eczema. Close inspection on the other parts of the body would have removed any confusion that might have at first occurred.

Finally, in the differential diagnosis of small-pox the following points should be kept in mind: First, one should consider the possible sources of infection. This may not be easily discovered in isolated or sporadic cases, nor at the beginning of an epidemic. Second, in the eruptive fevers, whether or not the patient has previously had the one to which the symptoms most strongly point. This, however, should not be too strongly relied upon, especially in measles and scarlet fever, although with them one attack is commonly known to confer more or less immunity to subsequent invasion. Third, the disease is most liable to be variola, when the most prominent symptoms are: sudden onset of chills or rigors, severe headache, backache, and vomiting, accompanied by a rapid rise of temperature, with delirium, constipation in adults and diarrhœa in children. Finally, with the supervention of sweating, furred tongue, fœtid breath, and the appearance of an irregular erythematous or petechial rash, first appearing and best marked

on the crural triangle of Simon, little doubt may usually be entertained as to the nature of the affection.

PROGNOSIS.

In prevaccination days small-pox was the greatest scourge that has ever afflicted the human race, and now, in countries where vaccination is not performed, the death-rate from this disease is extremely high. Thus, in Donarnenez, a small city in Finistère containing about 10,000 inhabitants, where vaccination had been singularly neglected, an epidemic of small-pox broke out in 1887 and 1888, in which 1931 persons, nearly one-fifth of the entire population,[133] perished. The prevalence of small-pox in Germany may be inferred from a quaint old saying: *Von Pocken und Liebe bleiben wenig Menschen frei.*[134] According to Neve,[135] fully 75 per cent. of the entire population of Cashmere die in infancy from small-pox. Since the investigations of Jenner in 1799, in which vaccination received scientific recognition, small-pox has lost its appalling fatality, and is now known to be amenable to perfect control. Unfortunately ignorance and the prejudices arising therefrom render protective measures to a certain degree ineffective. In the prognosis of small-pox we must consider at the outset whether or not the patient has been vaccinated and the time since the last successful vaccination. In Great Britain two of the strongest advocates for thorough vaccination are MacCombie and J. W. Moore, both having had largely to do with small-pox epidemics covering many years in institutions in which accurate statistics have been compiled. I shall, therefore, take some liberty in quoting from their masterly contributions on this subject.

The general fatality of small-pox among those who have never been vaccinated is greatest in children between one and ten years of age, not infrequently reaching as high as 58 per cent. Thus, during the Sheffield epidemic, of 2892 unvaccinated children under ten years of age living in infected houses, 7.8 per cent. were attacked, while during the Warrington epidemic 54.5 per cent. of unvaccinated children under ten years of age living in infected houses were attacked. Not only is the resistance less at this period, but in infants at the breast the implication of the mouth, nose, and pharynx often seriously inter-

[133] Brouardel (P.): "Vaccinia," in "Twentieth Century Practice of Medicine," vol. xiii, p. 501.

[134] "From small-pox and love few escape."

[135] Neve (A.): The Lancet, 1887, ii, p. 609.

feres with proper nursing, thus determining the fatal issue. (Plate XX.) Before Jenner's discovery it is estimated that one-tenth of all the children born died of small-pox. Again, of the entire mortality occurring at all ages, it has been variously estimated that between 7 and 12 per cent. was due to variola. Between the ages of fifteen and twenty the fewest deaths occur. After the fortieth year and as old age approaches the fatality of small-pox is again high.

TABLE SHOWING NUMBER OF CASES, DEATHS, AND PERCENTAGE OF MORTALITY IN DIFFERENT QUINQUENNIADS UP TO THIRTY.
(Taken from MacCombie, in Allbutt's "System.")

	Unvaccinated.			Vaccinated.		
	Cases.	*Deaths.*	*Mortality, Per Cent.*	*Cases.*	*Deaths.*	*Mortality, Per Cent.*
Under 5 years. . .	1131	647	57.2	385	30	7.8
5 to 9 years. . . .	952	385	40.4	1,468	59	4.0
10 to 14 years.	607	155	25.5	3,080	90	2.9
15 to 19 years.	385	158	41.0	4,091	191	4.6
20 to 24 years.	276	128	46.3	3,486	321	9.2
25 to 29 years.	199	91	45.7	2,079	228	10.9
30 and upward . .	390	194	50.0	3,167	522	16.4
Totals	3940	1758	44.6	17,756	1441	8.1

In general the prognosis is worse in women than in men on account of the complications of child-birth and the conditions which favor the hæmorrhagic variety of the disease. On the other hand, irregular habits and the excessive use of alcohol render the death-rate among men likewise very high. Among prostitutes and dissolute persons of both sexes the prognosis of small-pox is always exceedingly grave. The same holds true of badly nourished and overworked persons who are confined to dark, ill-ventilated rooms, or those convalescing from febrile or other diseases. Again, those who are enfeebled by scrofula, tuberculosis, or syphilis are likewise prone to succumb when attacked with small-pox. It, therefore, follows that the previous condition influences to a high degree the course and fatality of the disease. Thus, in drunkards and people who have lived irregularly or eaten to excess, both the hæmorrhagic and confluent forms are common.

The death-rate is usually higher at the commencement of an epidemic than at its close, because those most susceptible or wholly unprotected are usually first attacked.

Furthermore, the period of greatest frequency in those who have been vaccinated occurs in young adults, between eighteen and thirty years of age. This arises from failure to revaccinate, and, as the protective influence wears off in time, the subject is rendered again susceptible. In nearly all civilized countries, where vaccination is in vogue, the disease is therefore most frequently encountered at this time. The death-rate, however, is low, although it varies in different epidemics.

This is illustrated by the following table taken from the "Report of the Royal Commission of England":—

During the Sheffield epidemic of 1887-88, of 825 vaccinated persons,

35.5	per	cent.	suffered	from	the	varioloid	type.
50.0	"	"	"	"	"	discrete	"
13.0	"	"	"	"	"	coherent	"
1.5	"	"	"	"	"	confluent	"

The variability referred to is probably largely dependent on the varying degree of virulence the virus of variola possesses at different times. Moreover, the prevailing epidemic must be taken into account, some epidemics being mild, while others are severe. Thus, of the large number of cases occurring in the epidemic which has prevailed throughout this country during the past three years, the mortality has not exceeded 1 or 2 per cent., while in severe epidemics it has reached as high as 30, 40, or even 60 per cent. In the "Report of the Municipal Hospital of Philadelphia for 1899" W. M. Welch gives the average mortality previous to the epidemic of 1894-95 as 58.38 per cent., while during the epidemic of 1871-72 the death-rate in unvaccinated cases reached the appalling figure of 64.41 per cent. In the epidemic of 1894-95 the death-rate was 18 per cent. This offers a strong contrast to the mild form just experienced, during which it has been difficult to keep patients within doors. It has been no uncommon sight to see "pest-house patients" playing games in the open air while the disease was still in the eruptive stage. That the prevailing type is mild there can be no question, as those unvaccinated likewise have had the disease in a mild form. It has been the exception, rather than the rule, to find the eruption assume a confluent form even on the face and hands.

On the other hand, the degree of resistance it encounters at different times and in different organisms must be taken into account. There can be no question that the fatality of small-pox, as well as other

diseases, is influenced by the general surroundings, and varies to some extent according as the hygienic condition of the locality is good or bad. In seasons of extreme cold, when the poor suffer from various privations incident thereto, the death-rate naturally is higher than when these depressing influences are not present. The same holds true in damp, or extremely hot, weather. For this reason the season of the year materially influences the mortality of small-pox. It occurs far more frequently and is accompanied by a higher death-rate during the winter months than in the summer, although in the latter it has been observed that during excessive heat the death-rate is also high.

From the foregoing it follows that races and communities in which general hygienic conditions are ignored may not only show a greater number of cases, but will present a higher death-rate, than when the opposite conditions obtain. In this way the high mortality from small-pox may be accounted for in the slum districts of large cities, and among negroes and Indians.

Of 850 cases reported by Curschmann (*loc. cit.*, p. 392), 235 suffered from variola vera, and of these 46 were hæmorrhagic and all died. Altogether there were 99 deaths, or about 42.5 per cent. If the hæmorrhagic cases are excluded, the mortality of the other varieties was 28.2 per cent. This, he remarks, is a high percentage, and was due to the character of the patients—hospital cases from the poorer classes. An average percentage can only be given approximately; in confluent small-pox it varies between 15 and 30 per cent.

Initial rashes occur usually in mild cases, and when the initial rash is of a mild nature the prognosis is good. On the contrary, severe initial rashes do not necessarily indicate that a fatal or even severe disease will follow. If a general erythema occurs with moderate fever in which the temperature does not exceed 100° F. (37.7° C.), and especially if the rash assumes a dark, dusky, or vivid color and is most marked in the abdomino-crural and axillary triangles, the case will probably be hæmorrhagic and therefore fatal. Partial erythemas or those occurring over small areas, of a pinkish color and unaccompanied by hæmorrhagic signs, are usually followed by mild attacks; but, if purple petechiæ in the groins or elsewhere accompany the general rash, the case will probably prove fatal, and, if accompanied by isolated dark spots resembling ink-stains, a fatal termination may be assuredly expected. In general, the prognosis as presaged by the initial rash, depends upon the depth of color the eruption assumes; thus, a dusky purple or blackish tint foretells hæmorrhagic small-pox, and consequently a fatal

issue; while the light rashes are followed by mild attacks and recovery. The same holds true of oozing of blood from the mucous membranes, or hæmaturia during the initial stage. Finally, the prognosis in individual cases may sometimes be foretold from the character of the early symptoms. In exceptional cases this may be done even in the prodromal stage. With mild constitutional symptoms when the rash occurs late on the fourth or fifth day the prognosis is invariably good. The reverse does not always hold true, for with severe prodromal symptoms and the early appearance of the rash the disease may likewise prove of a mild nature. In the eruptive stage the number of pocks usually determines the severity of the disease. In unmodified small-pox when the eruption is confluent on the face, head, arms, and back, recovery is doubtful, and a guarded prognosis should be given, while with a discrete eruption on the back, although confluent on the exposed parts (face, scalp, and hands) most patients recover. When the hæmorrhagic variety develops in the early eruptive stage the outcome is invariably fatal, while in cases in which the hæmorrhagic tendency appears, after the full development of the lesions the prognosis, although extremely grave, is not always hopeless. According to MacCombie, the presence of claret-colored areolæ encircling the majority of the vesicles early in the course of the eruption (second or third day) is a most unfavorable sign, and affords early evidence of the probably fatal termination of the disease. Again, hæmorrhages occurring on the lower extremities alone, due to their dependent position, do not necessarily indicate a severe or fatal form of the disease. Such patients often recover, although, as previously stated, convalescence is usually retarded.

Varioloid is seldom fatal, and, when death occurs, it is the result of complications, as in those debilitated by old age or some previous disease; while confluent small-pox is extremely dangerous, and the hæmorrhagic form the most fatal of all.

It is commonly observed that an eruption on the mucous membranes influences to a high degree the mortality of small-pox, in childhood by interfering with the obtaining of sufficient nourishment, while in adults who possess a latent tendency to disturbances of the bronchial tubes, bronchitis, pneumonia, and other affections of the lungs are very liable to ensue. When tuberculosis co-exists, the prognosis is unfavorable. In like manner the mucous membranes of the alimentary and genito-urinary tracts are sometimes involved, although usually to a less degree, when the prognosis is uncertain. When diarrhœa, accompanied

by restlessness and delirium supervenes, the gravity of the disease is heightened. Symptoms of grave cerebral disturbance—such as delirium, convulsions, and coma—are always to be looked upon as extremely grave.

The duration of small-pox varies in different epidemics and in individual cases. Varioloid often terminates within ten days or a fortnight, while severe cases or variola vera usually last from six to nine weeks. When complications occur the disease may be protracted indefinitely.

TREATMENT.

In the treatment or management of small-pox two main considerations present themselves to the physician: First, the prevention of its spread to others, and, second, the actual treatment of the disease itself. In regard to the first much may be done, and in communities sufficiently intelligent to heed the advice of one skilled in this department of medicine, or in isolated localities which are strictly under the control of the health authorities, the disease may be held in complete control. Under the second head it may be stated at the outset that no specific treatment can be given that will invariably either cut short an attack already commenced or modify to any great extent the severity of its symptoms.

Preventive Treatment.—The prophylaxis of small-pox is by far the most important consideration at the outbreak of the disease. Small-pox being highly contagious and its virus retaining its virulence a long time, it is essential that the rules governing its spread and extermination be well understood.

Quarantine.—The first thing to do when a case of small-pox occurs is to notify the officer of public health. Strict quarantine should be immediately established and no one allowed either to enter or leave the infected dwelling. If possible, especially in thickly settled communities, the patient should be removed in an ambulance, maintained for the purpose, to a small-pox hospital. Such a hospital should be established in all cities, together with a place for detaining suspected patients or those known to have been directly exposed to the disease. The buildings should be separate and situated within easy access, so that the dangers incident both to the patient and community during transportation may be minimized. In towns where no such arrangements exist an isolated building should, if possible, be secured. When this is found impracticable, a large room as far distant from the living

rooms as possible should be selected and cleared of all articles not in actual use. A sheet kept constantly saturated with a 3-per-cent. solution of carbolic acid, chloride of lime, or corrosive sublimate (1 to 1000) should be hung outside the door. The efficacy of quarantine in preventing the diffusion of small-pox may be illustrated by the absence of the disease in countries which, from their geographical position or wide separation by a long sea-voyage from infected ports, enjoy a natural isolation. Not until 1838 did the disease appear in Australia, and it is said that by observing rigid rules of quarantine it was soon stamped out and did not reappear until 1868. Further, this second invasion soon died out, and by the careful inspection of incoming ships it has been found possible to prevent subsequent importations.[136] New Zealand has (1891) likewise enjoyed complete immunity.

Vaccination.—Second, all persons known to have been exposed should be vaccinated. It seems well-nigh incredible that vaccination as a protective means against small-pox should receive anything but an unqualified approval at this day. The public, however, are not especially enlightened on the communication of disease; hence a tempting field is offered for those who seek notoriety by posing as opponents to that which has been the means of saving millions of lives, one of the greatest boons vouchsafed to the human race. Thus, books have been written condemning vaccination in the highest terms, and endeavoring to prove by statistics its futility as a protective agent. Consequently it becomes necessary in this connection to state concisely a few imporant facts relative to the subject of vaccination.

Few realize the enormous change which has taken place in regard to deaths from small-pox since the introduction of vaccination. In Europe during the eighteenth century the deaths averaged about one-half a million annually. That vaccination prevents small-pox in the great majority of cases no one who has had much to do with the disease doubts. That in a limited number of cases those who have been vaccinated afterward contract small-pox does not militate against its value as a prophylactic measure. Especially is this true when such attacks are known to be of a mild nature and seldom fatal. That those, who, having once been vaccinated, may subsequently return to a susceptible condition after the lapse of a certain though variable length of time is likewise well acknowledged. That in the process of vaccination pus organisms and other extraneous septic substances are

[136] Hirsch (August): "Historical and Geographical Pathology," 1881, vol. i, pp. 133 and 134.

oftentimes introduced through the carelessness of the operator and his failure to institute proper precautions, thus causing inflammations which sometimes result seriously, cannot be denied. On the other hand, and I believe more frequently, the utter disregard of all cleanly habits on the part of the patient and his want of appreciation of the importance of asepsis, accounts for many of the complaints raised against the practice of vaccination. That such accidents in no way militate against the value of vaccination, as a preventive measure, nor disprove its harmlessness when properly performed and properly cared for, must be evident. The subject of vaccination and its influence in reducing the prevalence of, and mortality from, small-pox has been exhaustively studied in England by a commission appointed by the government for this purpose.[137] The importance attached to the findings of this commission will scarcely be questioned when it is known that it included such well known medical men as Paget, Savory, Bristowe, Jonathan Hutchinson, and Michael Foster, together with a few public men of various opinions. The commission finally finished its labors in 1897, having extended over a period of eight years. Experts were secured to study various epidemics in Great Britain, 187 witnesses were examined, and 136 meetings were held. In arriving at its conclusions the commission brought to light much valuable information relative to the subject of small-pox in all its bearings.

For example, carefully compiled statistics as to the effect of vaccination in five towns of England in which epidemics occurred are given as follows:—

	Attack-rate Under Ten.		Attack rate Over Ten.	
	Vaccinated.	*Unvaccinated.*	*Vaccinated.*	*Unvaccinated.*
Sheffield	7.9	67.6	28.3	53.6
Warrington	4.4	54.5	29.9	57.6
Dewsbury	10.2	50.8	27.7	53.4
Leicester	2.5	35.3	22.2	47.6
Gloucester	8.8	46.3	32.2	50.0

That vaccination favorably effects the mortality-rate and the severity of the disease even in persons who contract it afterward is likewise very clearly brought out by the report of the commission. In

[137] "Vaccination and its Results. A Report based on the Evidences taken by the Royal Commission, 1889-97." New Sydenham Society (London, 1893).

Sheffield, for instance, of 4151 vaccinated persons attacked, 200—or 4.8 per cent.—died; of 552 unvaccinated persons attacked, 274—or 49.6 per cent.—died; so that the mortality among the unvaccinated was more than ten times greater than among the vaccinated. Of those attacked, 353 were vaccinated children under ten years of age, of whom 1.7 per cent. died; while of 228 unvaccinated children attacked, 43.9 per cent. died; so that among children the disease was more than twenty-five times as fatal among the unvaccinated than among the vaccinated. Statistics like the above might be multiplied almost indefinitely, showing clearly that under compulsory vaccination the disease not only tends to be changed from one of childhood to one of adult life, as has previously been shown, but of even greater moment that it is much less fatal among those attacked.

Of 5321 cases of small-pox at the Municipal Hospital of Philadelphia, Welch observed only 2 vaccinated children (*loc. cit.*, p. 566).

It has been found that the period immediately following the introduction of vaccination is, in all countries, characterized by a marked, though irregular, diminution of small-pox mortality. That the nineteenth century has witnessed epidemics of considerable severity even in countries where vaccination has largely prevailed cannot be denied, but there has always been in those countries a class, more or less numerous, of unvaccinated persons. Moreover, experience teaches that the protective effect of vaccination diminishes in force, or may even disappear after the lapse of, say, ten years from the date of operation; hence there may be always found persons supposed to be made immune by vaccination but in whom the protective influence has disappeared, who are liable to be attacked and to suffer more or less from the disease. That epidemics have from time to time occurred, and that deaths from small-pox continue, cannot, therefore, reasonably be accepted as a proof that small-pox is uninfluenced by vaccination.

Duration of the Immunity.—Jenner at first thought that vaccination insured immunity for life,[138] but as early as 1805 it was observed that epidemics of small-pox occurred in communities supposed to be protected by vaccination. During the first quarter of the nineteenth century these epidemics increased in number and severity, which led to the conclusion that the protective influence of vaccination became

[138] "Vaccination, duly and efficiently performed, will protect the constitution from subsequent attacks of small-pox as much as that disease itself will. I never expected it would do more, and it will not, I believe, do less." Baron, "Life of Jenner" (London, 1838), vol. ii.

gradually less, and in some, at least, wholly disappeared. It was further observed that, in many, exposure to small-pox resulted in what was called varioloid, because it was supposed to be a distinct disease resembling small-pox. To Husson and Bousquet[139] has been given the credit of advising revaccination, which was first practiced on a large scale in Prussia. Of great importance in this connection is the effect of a law passed in Prussia in 1874 making revaccination compulsory. Since that period the small-pox mortality in that country has been reduced to proportions quite insignificant as compared with any previous epoch. It is likewise instructive to compare the deaths from small-pox per 100,000 of the population in Prussia and Austria, where revaccination was not enforced. It may be said that prior to 1874 the mortality from small-pox varied from year to year, being sometimes greater in one country, sometimes in the other, but subsequent to the passage of the law making vaccination compulsory in Prussia the contrast is remarkable. The figures for 1874 and for some years prior and subsequent to that date are therefore worth placing side by side:—

	Prussia.	Austria.		Prussia.	Austria.
	Revaccination not Compulsory.	*Revaccination not Compulsory.*		*Revaccination Compulsory.*	*Revaccination Compulsory.*
1862	21.06	31.14	1872	262.37	189.93
1863	33.80	53.10	1873	35.65	323.36
1864	46.25	84.78	1874	9.52	178.19
1865	43.78	45.53	1875	3.60	57.73
1866	62.00	36.85	1876	3.14	39.28
1867	43.17	74.08	1877	0.34	53.18
1868	18.81	33.27	1878	0.71	60.59
1869	19.42	35.18	1879	1.26	50.83
1870	17.52	30.30	1880	2.60	64.31
1871	243.21	39.28	1881	3.62	82.67

Further striking instances of the effect of revaccination might be given. For instance, the staff of the Small-pox Hospital at Leicester in 1892 consisted of 28 persons, 14 of whom had either previously had small-pox or had been revaccinated before the outbreak of the epidemic. Eight others were vaccinated at the time of the outbreak. The remaining 6 had been vaccinated in childhood, but refused to be revaccinated. Of the 28 persons, 6 were attacked by the disease and 1 died. Five of those attacked, including the fatal case, were among

[139] Bousquet: "Traité de la vaccine et des éruptions varioleuses au varioliformes" (Paris, 1833).

the six persons who had refused to be revaccinated. The sixth case was that of a nurse who had been revaccinated ten years before. In the epidemic at Warrington, of the 593 vaccinated cases, 323, or 54.5 per cent., were mild; 141, or 23.8 per cent., were discrete; 129, or 21.8 per cent., were confluent. Of the 68 unvaccinated cases, 3, or 4.4 per cent., were mild; 17, or 25 per cent., were discrete; 48, or 70.6 per cent., were confluent. That is, of the vaccinated cases 54.5 per cent. were mild and 21.8 per cent. were confluent. Of the unvaccinated, 4.4 per cent. were mild and 70.6 per cent. were confluent.

According to Marson, during the period of thirty-five years preceding his report (1871) no nurse or servant at the London Small-pox Hospital had been attacked with small-pox. Since then up to the present time one case only, that of a gardener, has occurred; so that there is now a record of nearly seventy years with one case only. Of the 137 nurses and attendants employed since 1883, all who had not previously had small-pox were revaccinated upon entering, with the exception of the gardener, who took the disease. Investigations by a committee from the Epidemiological Society of London showed that of 1500 attendants and others connected with small-pox institutions, only 43 were found to have contracted the disease, and not one of these forty-three had ever been revaccinated.[140] Welch states that at the Municipal Hospital of Philadelphia during a period of twenty-five years no one who has recently been vaccinated has contracted small-pox (*loc. cit.*).

In the author's experience, no instance has ever occurred of a physician, nurse, or attendant contracting small-pox in the discharge of duty in a small-pox hospital or pest-house who had a short time previously been carefully vaccinated.

The commission previously referred to ascertained that, if hospital experience be regarded as a whole, there is clear evidence that, while the revaccinated attendants escape small-pox, many of those who have neither passed through an attack of small-pox nor been revaccinated are attacked by the disease. Moreover, it cannot be asserted that persons employed in hospitals as medical men or attendants, even if revaccinated, enjoy an absolute immunity from the disease. There are instances of such persons having been attacked, but they have been so rare and exceptional as not to substantially modify the conclusion otherwise arrived at.

The *conclusions* formulated by the Royal Commission are as fol-

[140] "Transactions of the Epidemiological Society," 1885, vol. v, New Series.

low: "We have not disregarded the arguments adduced for the purpose of showing that a belief in vaccination is unsupported by a just view of the facts. We have endeavored to give full weight to them. Having done so, it has appeared to us impossible to resist the conclusion that vaccination has a protective effect in relation to small-pox. We think:—

"1. That it diminishes the liability to be attacked by the disease.

"2. That it modifies the character of the disease, and renders it (*a*) less fatal and (*b*) of a milder or less severe type.

"3. That the protection it affords against attacks of the disease is greatest during the years immediately succeeding the operation of vaccination. It is impossible to fix with precision the length of this period of highest protection. Though not in all cases the same, if a period is to be fixed, it might, we think, fairly be said to cover, in general, a period of nine or ten years.

"4. That, after the lapse of the period of highest protective potency, the efficacy of vaccination to protect against attack rapidly diminishes, but that it is still considerable in the next quinquennium, and possibly never altogether ceases.

"5. That its power to modify the character of the disease is also greatest in the period in which its power to protect from attack is greatest, but that its power thus to modify the disease does not diminish as rapidly as its protective influence against attacks, and its efficacy during the later periods of life to modify the disease is still very considerable.

"6. That revaccination restores the protection which lapse of time has diminished; but the evidence shows that this protection again diminishes, and that, to insure the highest degree of protection which vaccination can give, the operation should be, at intervals, repeated.

"7. That the beneficial effects of vaccination are most experienced by those in whose case it has been more thorough. We think it may fairly be concluded that, where the vaccine matter is inserted in three or four places, it is more effectual than when introduced into one or two places only; and that, if the vaccination marks are of an area of half a square inch, they indicate a better state of protection than if their area be at all considerably below this."

After viewing the subject in the broadest light there can be no doubt that, of all measures against the spread and fatality of small-pox, vaccination and revaccination occupy the highest position, and if thoroughly carried out would eventually wholly stamp out the disease. In

fact, although it is a matter of common remark that statistics are misleading, I believe it is hardly possible for an unprejudiced person to go over statistics with reference to small-pox which have not been collated unfairly without concluding that vaccination is effective, not in the absolute sense, but in proportion to the thoroughness with which it is carried out; that recently vaccinated persons in whom the virus has taken in a thoroughly typical way are practically insusceptible to the disease; that as the years go by they become more and more susceptible to it, but that persons who have been once vaccinated are, even after many years, less liable to the disease in the severer form. These facts point very strongly to the necessity of revaccination.

In answer to the question, as to when revaccination should be performed, the following statistics[141] are of interest. In these tables S denotes successful cases, F denotes failures. Calf lymph prepared with glycerin was used, and all persons who presented themselves were revaccinated. The lymph was inserted in four places on the arm. Table A includes 148 children who had all been vaccinated in infancy. No revaccinations were successful in children under four years of age. Table B is of 183 persons over twenty-four years of age who had been vaccinated later in life than the fourteenth year.

TABLE A. NUMBER OF YEARS SINCE LAST VACCINATION.

4		5		6		7		8		9		10		11		12		13		14	
S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
3		6		7		6		15	1	14		19		20		15		16		26	

TABLE B. NUMBER OF YEARS SINCE LAST VACCINATION.

1		2		3		4		5		6		7		8		9		10	
S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
	12		13		6		8		2		6		1	1	4	1	2	2	2

11		12		13		14		15		16		17		18		19		20		Over 20	
S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
	12	1	2	2	8		3	2	1		2			1		1	2			82	4

It is interesting to note that, of 148 children revaccinated at such

[141] Carter (R. J.): The Lancet, 1897, i, p. 1611.

varying intervals as from four to fourteen years after the last vaccination, all except 1 were successful. Of those who had been vaccinated after the age of fourteen the first successful case was eight years after the previous vaccination, and then only 1 case out of 5 succeeded. Even after an interval of fifteen to twenty years the evidence in these cases is strong that some of them were still protected. It is fair to assume that successful revaccination shows a previous susceptibility to small-pox in at least the milder form. This is as well established as any fact in the whole range of science, medical or otherwise. It is a foregone conclusion that any opinion on this subject which may be arrived at, no matter how well borne out by experience, will be bitterly attacked by a number of persons, just as it is the fact that there is no theory, however absurd, which will not be supported by some persons even of otherwise apparently good intellect.

When the patient and those immediately associated with him are seen to, the community should receive attention. All those who cannot show recent marks of vaccination should be vaccinated. It is often asked: how long after exposure to small-pox may vaccination be successfully performed. Bryce,[142] of Edinburgh, long since determined the period of complete immunity by making fresh inoculations every day after the primary vaccination. He found, while the effect grew less each day, that pustules, more or less conforming to the type, developed at the seat of inoculation up to the ninth or tenth day, after which no specific reaction could be obtained. Considering the different periods of incubation, it is generally conceded that to obtain immunity from small-pox not more than three or four days should elapse from the time of exposure to the insertion of the vaccine-lymph. On vacating the apartment occupied by the small-pox patient and his immediate family, the rooms should be thoroughly disinfected, and their contents either disinfected or destroyed.

Disinfection.—The virus of small-pox is very resistant to the ordinary modes of disinfection, and, as elsewhere shown (page 82), may retain its virulence several years. Where proper appliances are not at hand, or for other reasons there is danger that prophylactic measures may not be fully carried out, the safest measure is destruction by fire. When, however, such radical measures are deemed unnecessary, the following plan may be adopted: All washable objects, such as bedclothing, curtains, towels, handkerchiefs, underclothing, etc., should

[142] Bryce (J.): "Practical Observations on the Inoculation of the Cow-pox" (Edinburgh, 1809).

be immediately immersed in a solution of chlorinated lime, or corrosive sublimate (1 drachm to the gallon of water), or they should be tied up in a clean sheet and boiled for an hour, after which they should be taken out and exposed to the air and sun. Mattresses, old clothing, carpets, ornaments, pictures, rags, etc., of little value, as well as all articles injured by water or scrubbing, had better be burned. The room should then be fumigated by placing from 1 to 2 ounces (according to the area to be acted upon) of corrosive sublimate (mercuric chloride) on a plate which is heated over a spirit-lamp or charcoal-fire in the centre of the room. The windows, doors, and other apertures are then closed for about four hours, when they are opened and the room freely aired. As an extra precaution and to neutralize any of the mercurial vapor which may linger about the room, König[143] advises that on the following day the room be again closed and sulphur, 1361 grammes to 400 cubic metres of air-space (3 pounds to 1000 cubic feet), burned in the same way and the fumes retained four hours. Should it be necessary to enter the room during the process of fumigation, precaution should be taken to guard against inhaling the vapor by holding a moist cloth or sponge over the mouth and nose. The room and its contents should then be thoroughly scrubbed with strong potash soap or a bichloride solution (1 to 2000), taking special care that all corners and cracks are properly seen to, when it may be redecorated by painting, whitewashing, or papering, as desired. Harrington[144] has demonstrated the value of formaldehyde as a surface disinfectant, and the author's experience with it during the epidemic of 1898-1901 confirms its practical application in the exanthemata.

The preparation of formaldehyde best suited to surface disinfection is the aqueous solution, the strength varying from 10 to 20 per cent. For general interior or furniture disinfection a solution not weaker than 15 per cent. should be used, in the form of a fine spray. Clothing may be immersed in a tub containing the solution, after which it is hung up until dry. After spraying the walls, ceiling, floor, all articles in the room are to be washed with a 15- or 20-per-cent. formalin solution, allowing 24 ounces (720 grammes) for each 1000 cubic feet (400 cubic metres) of space, and the doors and windows closed for three or four days. A formaldehyde spray is the most convenient means of disinfection for physicians to use in leaving the infected dwelling or hospital. In carrying out our work during the epidemic mentioned,

[143] König: *Vide* J. W. Moore, p. 459.

[144] Harrington (C.): Amer. Jour. of the Med. Sci., 1893, p. 56.

notwithstanding the exposure resulting from the use of a camera and the development of plates at the photographers, together with the admission of the senior medical class, no instance of infection occurred. On entering the hospital, hats, gloves, overcoats, etc., were left in an anteroom, long linen gowns were put on, and the head covered with the same material. Rubber answers equally well, and it is always advisable to wear rubber boots. Before returning to the anteroom these garments were sprayed with a 20-per-cent. formalin solution. Upon entering the anteroom they were removed and thrown into a receptacle containing the same solution. The various articles of clothing were then sprayed as they were put on, and the camera, plate-holders, etc., were subjected to the same procedure. According to the health officer's report,[145] 150 infected houses were disinfected with this substance without the subsequent development, so far as known, of a single case of variola.

Heat (230° F., or 110° C.), in the form of hot air or superheated steam, is an efficient method of disinfecting when the necessary appliances are available.

In the country or in the absence of proper sewer connections, the excreta should be passed into a vessel and immediately disinfected by adding at least an ounce of fresh chloride of lime in solution, or a pint of the corrosive-sublimate solution, after which they should not be thrown into a vault, but buried at least 100 feet from a well or dwelling. When a water-closet is used the lime solution should be thrown into the basin after it is used and followed by thorough flushing.

Hygienic Measures.—Naturally anything that impairs bodily vigor lessens the resistance to disease, small-pox included. Therefore one exposed to variola should avoid fatigue, worry, and dissipation, especially alcoholic excess, which renders its *habitués* not only more prone to the disease, but, when attacked, assures a grave, if not fatal, issue. It is not advisable to enter the sick-room fasting or when perspiring. As an additional protective measure, a moistened cloth or sponge may be worn over the mouth and nose.

The restrictions imposed upon suspected cases may be removed at the end of twenty-one days, provided no symptoms of small-pox appear.

After recovery the patient should be given a momentary bath in corrosive sublimate (1 to 4000), carbolic acid (1 to 100), or formaldehyde (2 to 100), which should be immediately rinsed off with warm

[145] Hess (J. L.): Cleveland Jour. of Med., December, 1889.

water. He should then be supplied with new or thoroughly disinfected clothing, when he may be allowed to depart.

When death occurs the body should be immediately wrapped in a wet sheet dipped in a 1-to-2000 solution of corrosive sublimate; a 20-per-cent. solution of formaldehyde; or carbolic acid, 4 ounces; water, 1 gallon (120 grammes to water, 3840 cubic centimetres) (see formulary at end of volume). All clothing used about the patient should be burned. The body should be placed in a tight receptacle and buried without delay.

Treatment of the Disease.

In considering the treatment of small-pox the immediate surroundings of the patient should receive attention. The prevalent idea, which has come down to us from the dark ages, that those suffering from small-pox, as well as other eruptive fevers, should be confined in hot, close rooms, or covered up in bed with heavy blankets to induce copious perspiration, is erroneous. A large, cool, well-ventilated room, with a temperature varying from 65° to 68° F. (18.3° to 20.0° C.), with free ventilation without allowing draughts of air to strike the patient, should, if possible, be secured during the whole course of the disease. It is highly desirable that a bath-room adjoin the sick-chamber. An open fire-place is beneficial to secure free ventilation and change of air without producing draughts.

The body and bed-linen should be of the softest material, and the bed-coverings should not only be soft, but of light weight. A hair mattress on wire is sufficiently comfortable, although, in some instances of confluent small-pox, a water bed is required. The bedclothing, as well as the furnishings of the room, should be of washable materials, or of little value that they may be afterward destroyed by fire.

The importance of competent nursing cannot be too strongly urged. The custom unfortunately in vogue in many "pest-houses," of employing an incompetent keeper to act in the capacity of general manager and nurse, cannot be too strongly deprecated. Intelligent, trained nurses are essential in all well-regulated small-pox hospitals. Not only is skilled nursing conducive to the material comfort of the patient, but in many cases it determines the issue of life or death. A nurse should be sufficiently strong to assist the patient in changing his position, or in moving him from place to place should occasion require. Cleanliness is essential, and, as the discharge is copious, frequent changing of bed-linen and clothing which comes in contact with

the patient should be carefully seen to. In this the patient should be handled with the utmost gentleness, the nurse's arms being placed under a pillow upon which the patient rests, rather than directly touching the skin. What may seem to be a slight pressure or irritation is oftentimes excruciating to the sufferer. Again, in the management of delirious subjects the utmost care must be enjoined, lest during the nurse's absence the patient inflict upon himself irreparable injury. Not infrequently they leap from open windows, and, when exasperated, may inflict upon others bodily harm.

The question of light in the treatment of small-pox dates back to a very early period, as we have previously shown.[146] John of Gaddesden advised that red curtains, red walls, and red furnishings be employed, for in this color there was, he believed, a peculiar virtue. After lying well-nigh dormant for centuries, the subject of light in the treatment of small-pox has again been revived, and is receiving attention. From the fact that the eruption is most severe on parts exposed to the light, Black,[147] of England, concluded, from analogy as well as experimentation, that the complete exclusion of light in the management of small-pox prevents the severity of the eruption and consequent pitting of the face. Subsequently Waters,[148] of London, asserted that if white light (daylight) is entirely excluded from the patient the disease will be less severe. Likewise Barlow,[149] of Manchester, advocated exclusion of light in the treatment of small-pox. He mentions an experiment made in a case of confluent small-pox by covering one-half the face with a warm solution of colored gelatin, thus excluding the actinic rays, the rest of the face being left exposed to the full action of light; the result showed a marked contrast between the two sides; the protected side, being less severely affected, showed little or no scarification, while the part remaining free was covered with deep, suppurating lesions and consequent marked disfigurement. Barlow further recommends in the treatment of small-pox that only the actinic rays of the solar prism be cut off, thus obviating the depressing effect on the mind which total darkness would probably cause. Gallavardin[150] reports his observations on the effect of excluding light in the treatment of small-pox during a period of seven years. The method employed was to place the patient in total darkness, maintaining that the method is effectual only when

[146] Averroës (d. 1198), p. 14.
[147] Black (C.): The Lancet, June 29, 1867.
[148] Waters (J. H.).: The Lancet, February, 1871.
[149] Barlow (W. H.): The Lancet, July, 1871.
[150] Gallavardin: Lyon Méd., 1892, lxx, pp. 220 *et seq.*

thus thoroughly carried out, in which case suppuration and pitting are prevented. To Unna,[151] Widmark,[152] and Hammer[153] we are indebted for valuable investigations as to the effect of light in certain diseases of the skin. These observers have determined that it is the chemical rays of sunlight which alone are active in causing both pigmentation and solar eczema. Hammer and Widmark have shown that the same phenomena may be observed from a strong electric light, since it is particularly rich in chemical rays. These observers have further demonstrated that the chemical rays constitute essentially the blue and violet, especially the ultraviolet part of the spectrum, which of all light rays are the most refrangible. Under their influence chemical activity is strongest, while caloric activity is weakest. The converse of this holds true in the other end of the spectrum, where the red rays are found. Thus, the ultra-red rays were found to be the least refrangible, while with them the caloric activity was greatest and chemical activity the least.

According to Finsen,[154] of Copenhagen, Lindholm, Medical Officer of Health, and Svendson, Visiting Physician of the Municipal Hospital, during the summer of 1893, used either red curtains, which were kept tightly closed, or windows of red glass in the apartments occupied by small-pox patients, with gratifying success. The former states that when these precautions were thoroughly carried out œdema quickly subsided and the suppurative fever failed to appear. There were 20 patients thus treated, 10 of whom were unvaccinated children, and in all, though severely attacked, recovery took place. In 1 case of black small-pox the eruption dried up shortly after its appearance, no fever or maturation took place and only a few scars were produced. Svendson has also published an account of the treatment of small-pox by means of red light during an epidemic at Bergen,[155] in which his former experience was verified. Not only did the vesicles dry up without becoming purulent, but suppurative fever was entirely prevented, thus rendering the disease less protracted as well as less painful on account of the absence of destructive suppuration. In no case did pitting occur. Experiments were made by allowing 2 patients who had passed

[151] Unna (P. G.): Monats. f. prak. Derm., 1885, p. 285.

[152] Widmark: "Hygiea Festband," No. 3, and "Biol. Fören. Förhandl. Verhandl. d. biol. in Stockholm," 1888, I, 131-134.

[153] Hammer: "Ueber den Einfluss des Lichtes auf die Haut." "Verhandl. d. deutsch. dermat. Gesellsch.," Wien, 1892, pp. 329 *et seq.*

[154] Finsen (N. R.): "Om Lysets Indvirkninger paa Huden," Hospitalstidende, July 5, 1893; *ibid.*, September 6, 1893.

[155] Svendson: Medicinsk Revue, October, 1893.

through the stage of desiccation on the face, the disease being still active on the hands, to have free access to daylight, whereupon the lesions on the hands immediately took on a more active condition resulting in suppuration and deep pits on the backs of the hands in both cases. He concludes by saying that the clinical records of cases thus treated show the following important differences: The suppurative stage, which is usually the most dangerous as well as the most loathsome, passes over with little or no rise of temperature or œdema, the disease passing directly from the vesicular stage, which, in the cases observed, seemed to be somewhat protracted, to that of desquamation and convalescence. Furthermore this method prevents the disfigurement of pitting.

Juhel-Renoy,[156] of Paris, has likewise experimented by excluding from the room all but the red rays of light in the treatment of small-pox. He expresses himself with more conservatism by saying that the chemical rays of light cannot prevent suppuration, but lessen it to a marked degree, and are capable of rendering the scarification resulting therefrom less disfiguring. Feilberg,[157] of the Oresund Hospital, Copenhagen, in an epidemic which occurred in 1894, observed the effect of excluding the chemical light-rays in the treatment of fourteen cases. The results, he claims, were satisfactory and highly to be recommended. J. W. Moore (*loc. cit.*, p. 478), of Dublin, notes the effect of excluding the chemical rays in a case which developed the symptoms of confluent, if not hæmorrhagic, small-pox. He excluded all but the red rays by completely covering all windows in the chamber with thick red curtains which were always kept drawn, while another red curtain was hung before the door. In this case the secondary fever fell short of the primary by 2.2° F., and the rash, while dark in places, never became markedly pustular, although the contents of the vesicles were lactescent and opaque, and showed signs of hæmorrhage in many of the lesions. The patient made a good recovery. Moore further states that in the epidemic of 1894-95 patients admitted to the Cork Street Hospital, Dublin, were subjected to the red-light method of treatment, with the effect of reducing the number of eye complications, and at the same time of producing a light so agreeable that the patients voluntarily spoke of the color as "soothing." The writer has had occasion to observe the effect of red light in 13 cases. This was secured by covering the windows with thick red cloth and using electric lamps

[156] Juhel-Renoy: Bull. et Mém. de la Soc. Méd. des Hôp., December 14, 1893.
[157] Feilberg (C.): Hospitalstidende, July 4, 1894.

with red globes. Two of the patients were hospital nurses who had contracted the disease while attending a patient supposed to be suffering from an innocuous disease. In 1 the prodromal symptoms were severe and the patient was isolated on the morning of the second day. On the evening of the third day the temperature reached 105° F. (40.5° C.). On the fourth day the eruption appeared, when the fever subsided. The pocks underwent the usual changes until the third day of the eruption, when their contents absorbed, leaving elevated, small, pea-sized, transparent, firm, typical horn-pox lesions. These separated about the fifteenth to seventeenth day. In the second nurse the premonitory disturbances were less characteristic, although in both the catamenia were prematurely established. On the fourth day a few papules were observed, but which aborted, leaving firm papules in the skin. No. 1 had never been very successfully vaccinated, while No. 2 presented a slight reaction to the vaccine virus. It is impossible to draw any definite conclusions from only a few cases, but, from the success already obtained by the chemical or actinic rays of the solar spectrum in the treatment of lupus vulgaris, we are led to believe that much good may be accomplished by this method in the management of variola, and from the favorable reports already given it assuredly is worthy of further trial.

General Treatment.

Prodromal Stage.—The management of the prodromal stage seldom calls for any special interference. Of the various methods that have been suggested for ameliorating the subsequent symptoms or cutting short an attack of small-pox, nothing has proved of certain benefit. At one time all patients entering the Cleveland Small-pox Hospital were vaccinated at the earliest possible moment and before the maturation of the pocks, but we failed to see that it had any influence either in cutting short the disease or even of modifying it. While this procedure is advocated by Welch,[158] others, among whom may be mentioned Curschmann and MacCombie, have found it of no benefit.

In all cases as soon as the symptoms of small-pox appear it is advisable that the patient keep to his room, although in mild cases it is scarcely necessary to confine him to bed. Until the severity of the

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[158] Welch (W. M.): "Small-pox," in "American System of Practical Medicine" (New York and Philadelphia, 1897), vol. i, p. 513.

attack is determined, however, it is advisable to conserve his energy, which later may determine the outcome of the disease. To relieve the obstinate vomiting and retching often observed at this time, small pieces of ice may be placed in the mouth. Avoid hot fomentations or mustard plasters, lest they excite a confluent eruption. For severe frontal headache cold compresses or ice-bags usually afford the most relief. Active medication at this time should generally be avoided, although phenacetin, 5 to 10 grains (0.33 to 0.7 gramme), or the hypodermic injection of morphine may be resorted to when severe pain in the back, frontal headache, or excessive vomiting persists. Bleeding, purging, and sweating, considered so essential at one time, are now entirely discarded and thought to be injurious on account of their depressing effect. As the fever rises, and during its height, bathing or sponging with tepid water may be grateful, or a sheet may be wrung out of cold water and wrapped about the patient. In bathing it is advisable to begin with a temperature of 95° F. (35° C.), and gradually cool by adding cold water until 85° or even 80° F. (26.6° C.) is reached. This, however, is seldom essential before the eruptive stage, and is indicated only when the fever is excessively high. It is always necessary to see that the evacuations from the bowels are regular, and if necessary a mild aperient should be administered. Salines are preferable, such as Hunyadi water or sulphate of magnesium. Water should be given to drink freely; iced water especially is usually grateful to the patient, and it tends to lessen the fever. Lemonade is sometimes very refreshing, and may be given freely. The diet should be light and of easy digestion. Milk, meat-broths, and gruels are to be recommended.

Eruptive Stage.—The management of small-pox during this stage naturally depends on the extent and character of the eruption, as well as on the special symptoms present. In varioloid no special treatment is required, but in the confluent and hæmorrhagic varieties both judgment and care are necessary. The management of small-pox is, therefore, expectant, for no one can predict at the onset what form the disease may assume, nor what complications and sequelæ may be encountered. During the management of this stage, which is usually by far the most serious, the sources of danger to be guarded against are: first, collapse from the severity of the disease; second, the absorption of septic material which is met with as maturation progresses; and, third, complications, thus increasing the burden, which the already exhausted forces may be unable to withstand.

INTERNAL TREATMENT.

In confluent small-pox the patient should be placed in bed, and to maintain his strength diligent care must be taken to select a suitable dietary. Food must be taken at short, though regular, intervals. Nourishment is usually called for every two hours, although every three hours will suffice when larger quantities are taken. Again, in severe cases it may be thought advisable that nourishment be administered every hour. When the patient is delirious, or in a stupor, he should be aroused to enable him to take nourishment. When, however, he falls into a gentle sleep he should not be disturbed. The articles of food best suited are milk, soft-boiled or poached eggs, beef-juice, animal broths, meat essences, meat-jellies, arrowroot, sago, custard, and bread. In mild cases, especially if there is a tendency to constipation, fresh fruits may be given. Stewed or baked apples are usually highly relished. Bananas are likewise valuable in certain cases. When there is a tendency to diarrhœa, fruit should be withdrawn and boiled milk (4 parts), with lime-water (1 part), may be given. Vermicelli, gelatin, or arrowroot may likewise be added to the milk. If the digestive powers are exceptionally weak, the milk may be peptonized, the object of which is to convert the insoluble proteids and albuminoids into soluble peptonoids. Not infrequently when delirium is present some difficulty may be experienced in prevailing upon the patient to take sufficient nourishment. At such times it may be necessary to administer it either through a tube introduced into the nares, passing down to the œsophagus, or by means of nutrient enemata, the latter being usually preferable. In using an enema the rectum should first be flushed out with warm water and then an enema of milk, or beef-tea, or eggnog, at a temperature of 100° F. (37.7° C.), should be given. The amount at each administration should not exceed from 4 to 6 ounces (120 to 180 cubic centimetres). As a rule, a pint ($^1/_2$ litre) of animal broth or from $1\ ^1/_2$ to 2 pints (720 to 960 cubic centimetres) of milk in twenty-four hours will be found sufficient. When more than this is given, digestive disturbances are liable to follow. In low forms an adult should take about 2 or 3 quarts (1920 to 2880 cubic centimetres) of milk and from 2 to 3 raw eggs in twenty-four hours. Alcohol is sometimes indicated at this time, but it should not be given indiscriminately. Murchison[159] states that patients under twenty years of age, as a rule, do best without alcohol, whereas most patients over forty are benefited by it after

[159] See J. W. Moore (*loc. cit.*, p. 482).

the first week. Intemperate persons require alcohol early, and in greater quantities than others; yet even here there are instances in which it does not agree. The chief indications as laid down by Murchison for the use of alcoholic stimulants are derived from the state of the pulse, the heart, the effect on the brain, and from the presence of complications, and especially from the typhoid state as evidenced by stupor, low muttering delirium, tremor, subsultus, involuntary evacuations, coma-vigil, etc. In short, alcohol may be considered as beneficial to the patient: first, if under its use the heart's action becomes stronger and less rapid, the impulse increasing in strength and the first sound becoming more distinct; second, when a soft, compressible, undulating, irregular, or intermitting pulse becomes fuller and stronger and more regular in rhythm and volume; third, if a dry, brown tongue becomes clean and moist at the edges; fourth, if delirium lessens, the patient becoming more tranquil or even falling asleep. It should be remembered that the vitality of the patient is lower during the night, reaching its lowest ebb about four o'clock in the morning. Stimulants, therefore, are more frequently required during the night, while in the forenoon they are more seldom called for. Whisky (from 6 to 12 ounces, or 180 to 360 cubic centimetres, in twenty-four hours) in the form of milk-punch or eggnog is usually preferred. In cases of extreme prostration, as in severe confluent small-pox or in the hæmorrhagic variety, certain medicinal stimulants or tonics combined with alcohol may be given. Among those found the most useful may be mentioned carbonate of ammonium, the different ethers, sumbul, camphor, musk, turpentine, or quinine.

The second danger during the eruptive stage is the absorption of septic substances from the extensive suppuration present. It would be useless to enumerate the procedures that from time to time have been proposed to obviate this danger. Suffice it to say that almost all known substances have been used both externally and internally without producing very striking results. Foot[100] administered carbolic acid internally in the form of the sodium sulphocarbolate, 6- to 10- grain (0.46 to 0.6 gramme) doses, in water, every third hour. As the usual beverage he gave a drachm (4 grammes) of the sulphurous acid in a wineglassful or two of iced water, and sprayed the larynx, nares, and upper air-passages with a weak solution of either sulphuric or carbolic acid.

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[100] Foot (A. W.): Dublin Jour. of Med. Sci., vol. liii, pp. 242 *et seq.*

Pepper[161] has advocated cocaine in the treatment of small-pox, claiming that the disorganization of the blood is generally less rapid and less extensive, that the fever is less severe and of shorter duration, and that oftentimes the lesions undergo incomplete evolution or semi-abortion under its use. He further maintains that visceral congestion and inflammation are not so frequent, and that when present they are less intense. The dose given for a child five years old is from 2 to 4 drops of a 4-per-cent. solution four times during the twenty-four hours, and increased 1 drop for each year until, at the age of twenty, 20 drops are taken at the same intervals. The most important drugs, I believe, are strychnine and the various preparations of iron. During the epidemic of 1898-1901, after testing numerous preparations, we found the former by far the most trustworthy and important of all internal medicaments. Strychnine may either be given by the mouth or hypodermically. The dose should vary with the age and general indications, being from $^1/_{100}$ to $^1/_{25}$ grain (0.00065 to 0.0026 gramme), repeated every three or four hours. Later in the course of the disease the citrate of iron and quinine, in 5- to 10-grain (0.33 to 0.7 gramme) doses every four hours, likewise proved serviceable. Trinitrin, $^1/_{100}$ grain (0.00065 gramme), may also be used to tide over critical periods. Opium is of value in diarrhœa, and hypodermic injections of morphine, $^1/_8$ to $^1/_4$ grain (0.008 to 0.016 gramme), may be given to induce sleep. In children chloral-hydrate is to be preferred. On account of the irritating effect this drug has on the pharynx and larynx when these parts are implicated in the variolous process, Curschmann recommended it in the form of an enema, in which from $1\,^1/_2$ to 2 drachms (6 to 8 grammes) are given with 8 ounces (240 cubic centimetres) of water or mucilage. Digitalis is likewise of value, and may be given with advantage in certain cases of insomnia, as in the following, which is highly recommended by Murchison:—

℞ Liquoris opii sedativi.....3j (3.5).
Tincturæ digitalis .....3j (3.5).
Spts. ætheris nitrosi.....3ij (7.0).
Aquæ camphoræ .....℥vj (180.0).

M. Sig.: A sixth part at once, and afterward half a fluidounce every second hour until the patient sleeps.

Of the preparations of opium, the deodorized tincture, 5 to 7 minims (0.3 to 0.7 cubic centimetre), is one of the best. To reduce

[161] Pepper (E.): American Jour. Med. Sci., March, 1893.

fever phenacetin, 2 to 3 grains (0.13 to 0.2 gramme), every two hours may be taken until the temperature falls or several doses have been given. In hæmorrhagic small-pox iron in full doses (from 20 to 30 drops of the tincture every three or four hours); tannic acid, 5 to 10 grains (0.33 to 0.7 gramme); ergot, and turpentine are indicated. Unfortunately in most cases all efforts avail but little; but in the writer's experience full doses of turpentine and ergot have given the most promising results. In those cases Curschmann has used transfusion of blood without gratifying effects, and, finally, J. W. Moore suggests the inhalation of oxygen. He recommends that the mouth-piece be held a short distance away from, and below the lips of, the patient.

When the intestinal mucosa is involved, giving rise to copious diarrhœa, something more than the measures previously suggested may be necessary. In such cases in addition to the starch diet, wet compresses may be applied to the abdomen, or a simple starch enema, containing 10 to 20 minims (0.6 to 1.2 cubic centimetres) of laudanum, or the deodorized tincture of opium (Squibb's), 8 to 10 minims (0.6 to 0.7 cubic centimetre), may be resorted to. If the evacuations show signs of blood, the spirit of turpentine in 5-minim (0.3 cubic centimetre) doses may be given. When flatulent distension of the abdomen or hiccough occurs, 30-minim (1.8 cubic centimetres) doses of tincture of sumbul have been found highly serviceable. Moore further recommends hot fomentations, poultices, turpentine epithems, and—above all—ice poultices, which may be made by putting small pieces of ice between two folds of flannel. Should these fail, an enema is indicated or a long tube should be passed up the rectum so far as possible in order to give vent to the pent-up gas.

LOCAL TREATMENT.

When the eruption is confluent, local measures are highly important, and numerous methods have been recommended to meet the various indications of this critical stage. Stokes,[162] of Dublin, many years ago considered the three most important indications for treatment: exclusion of air, keeping the parts moist to prevent hardening of the scabs, and lessening local irritation. Thus, flexible collodion has been used, and masks composed of various substances have been recommended to meet the first of these indications. Lewentauer[163] recommends the employment of a mask in the form of a thick paste or oint-

[162] Stokes (W.): Dublin Jour. of Med. Sci., vol. liii, p. 9.
[163] Lewentauer: Bull. Gén. de Ther., No. 32, 1869.

ment, consisting of salicylic acid, 3 parts; starch, 30 parts; and glycerin, 70 parts. Bertrand[164] likewise recommends a protective mixture composed of 1 drachm (4 grammes) of boric acid and 1 $^1/_2$ ounces (43 grammes) of glycerin. This is best applied by means of a brush. Some German writers recommend the application of a paste composed of carbolic acid, 4 to 10 parts; olive-oil, 40 parts; and prepared chalk, 60 parts. This is to be spread on linen and applied to the surfaces where the eruption is most protracted. The application should be changed once in twelve hours. In France some recommend the application of a mercurial plaster (Vigo plaster), either in the form of strapping or by smearing the parts with an ointment of firm consistence. J. W. Moore (*loc. cit.*) applies a mask over the face, made of lint thoroughly soaked in iced water and glycerin, a teaspoonful to the ounce of water, and covered with oiled silk. Ihle's paste—a mixture of 10 grains (0.7 gramme) of resorcin with 2 drachms (8 grammes) each of powdered starch, oxide of zinc, lanolin, and soft paraffin—would probably suit some cases. In the earlier stages of the eruption Moore likewise recommends antiseptic and astringent dusting-powders, such as boric acid, subgallate of bismuth, refined Fuller's earth, or a carbolized powder like the following:—

℞ Acidi carbolici puri liquefacti.....3ss (1.8).
Zinci oxidi .....℥j (30.0).
Pulv. lycopodii .....℥j (30.0).
Misce.

The same writer further states that Hardwicke, of the Fever Hospital, Dublin, recommends the application of an ointment composed of native impure carbonate of zinc and glycerin. Marson, formerly of the London Small-pox Hospital, waited until the pustules had burst and the discharge began to desiccate, when he applied olive-oil, or a mixture of glycerin and rose-water in the proportion of glycerin, 1 to 3 of rose-water. He also recommended cold cream, or oxide of zinc or Carron oil (a mixture of olive-oil and lime-water). These are all more or less disagreeable to the patient, and are difficult to apply and maintain in position; besides, their application does not produce the effect which has sometimes been claimed for them. Of greater value is ichthyol (ammonio-sulphate), which is also well spoken of by Hoerschelmann.[165] It should be used in the strength of from 20 to 50 per cent. From what has previously been said, exclusion of light or its chemical

[164] **Bertrand**: Gaz. des Hôp., July 15 and 17, 1890.
[165] **Hoerschelmann (E.)**: St. Petersburg med. Woch., 1898, N. F., xv, pp. 383-386.

rays probably has greater effect than excluding the air. The second indication as given by Stokes includes the third, because, of all local measures during this painful stage, that of keeping the parts permanently moist is the best. Curschmann found cold, wet compresses applied to the face and hands the most grateful to the patient and soothing to the inflamed skin.

It is seldom possible to give a full bath in confluent small-pox, but when competent attendants and proper appliances are at hand, the continued bath, first recommended by Hebra (*op. cit.*), is highly to be recommended. Not only does it cleanse the surface and allay fever, but the patient is placed in the most comfortable environment and recovery is facilitated. It is not unusual to see those raving in delirium, or tortured by the slightest movement or contact of clothing, fall into a gentle sleep soon after entering the bath. The importance of this procedure warrants a more detailed description of the method of its employment. An ordinary bath-tub may be utilized for this purpose, although in small-pox hospitals the bath-tub should be at least six feet (2 metres) long by three feet (1 metre) broad. An iron bath-tub finished with enamel is the best, although any material will serve equally well. Within the tub is an iron or wooden frame to which are fastened transverse bands of webbing, such as is used by upholsterers. About two feet from one end of this frame a head support is attached by hinges allowing it to be placed at any angle desired and which may be secured by means of a ratchet. This frame is supported by two cords, one at either end, which pass over two small rollers; so that the whole may be easily raised or lowered within the bath. It is more convenient to rest the frame on two blocks of wood, which elevate it about six inches (0.15 metre) from the bottom of the tub; in which case handles must be fastened to the frame to facilitate its removal. When hot and cold water pipes are not supplied, the water may be maintained at the desired temperature by having a vessel made of copper or tin which can be heated. A supply-pipe from this heated reservoir should enter at the bottom of the bath while the escape-pipe allowing the cold water to flow away should be placed at the water-level. When the apparatus is in use the water should be kept constantly flowing, so that all impurities may be washed away. That the face may be likewise submerged or irrigated, small tubes provided with a rose or perforated nozzle are connected with the copper vessel or reservoir. It requires little mechanical skill to construct a water-bed suitable for the purpose. A blanket, evenly folded and

placed upon the frame, together with a hair pillow on the head-rest, completes the bed. Before entering the bath the tub should be filled with water at a temperature ranging from 90° to 100° F. (32.2° to 37.7° C.), according to the needs of the patient. It may be said that the object is usually not so much to lower the temperature as it is to furnish a detergent and soothing environment to the patient. It is useful to have a wooden cover upon which a blanket is spread to put over the lower part of the bath to prevent too rapid cooling. If desirable the head may likewise be covered by hooping over the bath-tub upon which the blanket may be placed. The patient should be allowed to remain in this bath for at least several hours, sometimes seven or more, each day, and if no contra-indications arise it may be prolonged indefinitely, provided the patient is removed for the calls of nature.

For the purpose of fully carrying out local asepsis, Foote (*loc. cit.*) covered the face with carbolized oil and sponged the body with solutions of sulphurous acid, and sulphur was frequently burnt in the room. Telamon[166] applied ethereal solutions of various antiseptics in the form of a spray. He recommends salol when the rash is slight and scanty, but in severe cases corrosive sublimate is to be preferred. Thus, the part may be sprayed for a minute three or four times a day, until desiccation takes place, with a solution consisting of corrosive sublimate and citric acid, of each, 15 grains (1 gramme); alcohol (90 per cent.), 80 minims (5 cubic centimetres), and ether, sufficient to make 1 $^1/_2$ ounces (50 cubic centimetres). The eyes should be guarded during the application.

It has been observed that at the onset of the disease anything that causes a determination of blood to the skin increases the eruption, and, conversely, that depleting measures lessen the size and number of the pocks. For this reason, the writer has found, after numerous trials, the most efficient local treatment in a large number of cases to be as follows: A felt or lint mask with apertures cut for the eyes, nose, and mouth, should be saturated with iced water and applied. To be effectual it must be used early, before the eruption appears and continued with frequent changing until the stage of desiccation. As soon as it can be determined that the eruption will be confluent, when the fever remains high, the scalp and beard should be closely clipped, and cool sponging or cold compresses to the confluent parts should be resorted to as early in the eruptive stage as possible. As the pocks

[166] Telamon: Méd. Mod., April 17, 1890.

mature, a saturated aqueous solution of boric acid may be used in the same way, or, in some instances, especially when suppuration commences, a solution of corrosive sublimate (1 to 2000) or carbolized water (1 to 2 per cent.) may be preferred. To be of service such applications should be made at short intervals and the compresses changed every fifteen or twenty minutes. When practicable, tense pustules should be ruptured with a lancet and the cavity flushed out with one of the antiseptic solutions previously mentioned by means of a fine-nozzled syringe. As the active suppurative stage subsides, a full, warm bath, in which the water is tinged with permanganate of potassium, is to be recommended. It should be remembered that the potassium permanganate is rendered inert by soap or any organic matter.

In children the convulsions which frequently supervene are best treated by warm baths. Not only may the best results be secured in this way, but they are measures found most agreeable to the patient, which of itself may be well worth considering. It is highly important that the crusts be separated as soon as possible, so that a more direct application of soothing, antiseptic dressings may be made. This is more especially true of the face and hands. Water dressings may now be replaced by some bland, oily substance, such as olive-oil or vaselin, to which boric acid (25 per cent.), carbolic acid (1 to 2 per cent.), or mercury (white-precipitate ointment, 5 per cent.) has been added. Although in the majority of cases it is impossible to wash the patient to any extent during the active eruptive stage, yet as incrustation and decrustation set in, the tepid bath, from one-half to one hour in duration, may be given daily with the view of facilitating the separation of crusts and cleansing the skin, after which it should be anointed.

When abscesses form they are to be opened early with a free incision, allowing no accumulation of pus to occur, and taking care that such cavities or sacks are thoroughly irrigated with the bichloride or boric solutions previously referred to. When pus oozes from ruptured pocks it should be also cared for by frequent sponging. A solution of nitrate of silver has frequently been recommended, but the writer must concur with MacCombie, that never has he been able to observe the slightest benefit from its use. The same may be said of dusting-powders. When the eruption on the face gives rise to severe itching, resorcin (3 per cent.) or carbolic acid (2 per cent.) should be applied, or it may be necessary to muffle the hands to prevent further disfigurement from scratching. When the early separation of the crusts cannot be accomplished by the moist dressings previously recommended, the

application of linseedmeal poultices may be advised. On the scalp a thick poultice with iodoform sprinkled on the surface may be applied in the ordinary manner, but on the face the method most agreeable to the patient is, according to MacCombie (*loc. cit.*), as follows: As desiccation takes place, a mask is made of a single thickness of lint with apertures for the eyes, nose, and mouth. A thin layer of linseed poultice is smeared upon this, taking care to put on the surface a little vaselin, with which iodoform has been mixed, and applied to the face, changing at least every two hours. By this means, according to this author, the crusts may be separated more rapidly than by any other method. On the legs, arms, and elsewhere a solution of boric acid or other watery antiseptic dressings, followed by carbolized vaselin, will be found sufficient in the great majority of cases.

During the stage of exudation particular attention should be given to the eyes. The aperture of the lids is often completely closed from œdema, allowing secretions to be retained which frequently decompose and set up a severe conjunctivitis. Moreover, small-pox lesions may occur upon the conjunctiva, and, as previously shown, not infrequently pursue a very rapid course; therefore the frequent inspection of the eyes is imperative. In simple conjunctivitis the lids should be elevated and the eye irrigated every hour or oftener with a saturated aqueous solution of boric acid, or the following:—

℞ Sodii chloridi ..... gr. viij (0.52).
Acidi borici ..... 3j (4.00).
Aquæ dest. ..... f℥iv (120.00).
Misce et filtra.

In more urgent cases a solution of corrosive sublimate (1 to 2000) may be dropped into the eye once or even twice daily. Again, that the eye may be placed at rest, atropia may be called for:—

℞ Atropiæ sulph. ..... gr. ij (0.13).
Aquæ dest. ..... f℥iv (16.00).
Misce.

A drop may be instilled into the eye every half-hour or until full dilatation is produced, after which twice a day will be sufficient to maintain the relaxation thus produced.

The use of the silver nitrate is growing less in favor, although it is highly recommended by some in severe conjunctivitis attending this disease. It may be employed in the strength of 10 grains (0.7 gramme) to 1 ounce (30 cubic centimetres) of distilled water. After its use, however, the eye should immediately be flushed with a 2-per-cent.

solution of the sodium chloride. When pustules form on the cornea, they must be incised at once, and to relieve tension the knife should be passed deeply into their base, after which the eye may be flushed with a warm, saturated solution of boric acid, followed by a solution of mercuric chloride (corrosive sublimate), which should be dropped into the eye once or twice daily. In the meantime the solution of boric acid, previously recommended, should be used freely every hour or as occasion demands. When ulceration takes place, a strong solution of corrosive sublimate (1 to 500) may be used. This is applied once or twice daily by means of a fine pledget of cotton, wound around a tooth-pick. It is advisable, before making this strong application, to use a 4-per-cent. solution of cocaine to deaden the sensibility. In these cases mydriasis should be maintained by atropia, as previously described. In all cases it is advisable to keep the room fairly dark, although the light should vary, being lighter during the day than at night. The red glass previously referred to is useful in obviating eye-complications. When ulceration of the cornea takes place, atropine and cold compresses must be used. If perforation, staphyloma, or extensive purulent iridocyclitis, or panophthalmitis occur, the services of an ophthalmic surgeon should, if possible, be obtained. Fortunately, destructive changes in the eye are far from common, and especially if the precautions herein given are carried out.

The nose and mouth must likewise receive attention, and frequent cleansing of the parts may become necessary. The mouth may be swabbed out with a saturated solution of boric acid, while in the nostrils it may be used in the form of a spray. Glyceride of tannin, 1 part, and distilled hamamelis, 3 parts, is an excellent application for this purpose. MacCombie recommends a mouth-wash composed of, the liquor of potassa and pure carbolic acid, of each, 1 part, to 80 parts of water. This may be further diluted, if necessary, especially in the case of children. If laryngitis exists, iced compresses to the throat may be made, or a tent so arranged by means of a sheet, in which steam or warm inhalations are introduced, that the patient may inhale both heat and moisture. When dyspnœa is great or when œdema of the glottis occurs, if not relieved by this method, tracheotomy may be called for. This operation is rendered extremely difficult in small-pox, on account of the œdema present and the excessive hæmorrhage which is liable to take place. Glossitis seldom requires any special interference; usually the application of finely powdered ice is sufficient; but, if the swelling is great, it may be necessary to make free incisions,

about half an inch in depth and one to two inches in length. If erysipelas occurs, the parts should be covered with equal parts of ichthyol and vaselin, or ichthyol may be applied pure, after which the parts may be enveloped in cotton-wool. In case of cellulitis, if extensive, deep incisions must be made early, followed by antiseptic flushings or hot fomentations. To assist the skin in regaining its natural condition after the small-pox lesions have disappeared, I have frequently given the following:—

℞ Sulphuris præcipitati ..... 3iij (11.25).
Acidi salicylici ..... gr. xx (1.3).
Glycerini,
Alcoholis ..... aa q. s. ad f℥iij (90.0).
M. Sig.: Apply at night.

This should be washed off with warm water and soap in the morning, after which the following may be applied with a pledget of cotton three or four times a day:—

℞ Acidi borici ..... 3iv (16.00).
Acidi salicylici ..... gr. xv (0.98).
Spts. lavandulæ ..... f3ij (0.70).
Alcoholis ..... f℥vj (180.00).
Misce.

Finally, it is to be borne in mind that the treatment, both of the complications and sequelæ of small-pox, does not differ from that employed in similar conditions unaccompanied by variola.

CHAPTER III.

VACCINIA.

THE deplorable condition which obtained during the latter part of the eighteenth century relative to the prevalence of small-pox rendered any measure that promised relief to be hailed with joy. The practice of inoculating a disease so loathsome and frightful in its consequences, which, under the most favorable conditions, was more or less severe, often resulting in disfiguring scars and sometimes fatally (variously estimated at about 2 in 1000) could not be generally introduced. Those who subjected themselves to inoculation, therefore, were the means of spreading the pest to the great mass of their unprotected fellows, who then contracted the disease in the regular way. This explains the prevalence, as well as the high mortality, of small-pox at this time. It was generally known that the court ladies and other devotees of fashion looked with enmity upon the immunity enjoyed by some of the dairy-maids in Gloucestershire to the pitting of small-pox. Long before Jenner's time it is related of the Duchess of Cleveland, who held a position in the service of King Charles I, the chief function of which was in close dependence upon her beauty, that, when joked by the courtiers on the possible loss of her occupation through the disfigurement of small-pox, she replied that she had nothing to fear, for she had had the cow-pox. A. von Homboldt is said to have observed the practice of vaccination as a protective measure against small-pox long before among the mountaineers of Mexico, and in Europe it was mentioned by Sülzer in 1713, and by Sutton and Fewster in 1765[167]; yet it is highly probable that its actual value remained unknown.

Jenner, while yet a student at Sudbury, observed the immunity to small-pox enjoyed by farm-hands and dairy-maids who had previously contracted sores on their hands from milking cows having pustules on their teats and udders, known as kine-pox. So far as known, however, vaccination was performed the first time with this end in view by one Jesty, a Dorsetshire farmer, in 1774, who, having seen the result of inoculation with cow-pox and knowing its protective value, submitted himself with his entire family to vaccination for the purpose of protection against the small-pox. This unsuspecting pioneer in the

[167] See Curschmann (*loc. cit.*, p. 401).

domain of science afterward presented himself at the Inoculation Hospital in London, and defied the physicians to give him or any of his family the small-pox. The physicians in attendance failed to observe anything extraordinary in this procedure; hence it was left to Jenner, a pupil of the great John Hunter, to utilize the great principles thus set forth, which was destined so soon to revolutionize the methods of combating the pest. Following up the observations made in his youth by painstaking experiments, Jenner[168] finally, in 1798, announced to the world the principles of what he termed *variolæ vaccinæ*. Unquestionably, therefore, to Edward Jenner belongs the credit of the general practice of vaccination. In 1799 the first public institution for vaccination was established in London. In 1800 it was introduced into France and Germany. In 1807, on account of numerous and spirited controversies as to the merits and demerits of the new custom, a commission was appointed by the Royal College of Physicians to investigate all known facts relative to the subject of vaccination. In reviewing the effects in several hundred thousand cases, the conclusion arrived at was that, though in some instances vaccination failed to protect, it afforded greater security against small-pox than the inoculation previously in use, while the illness introduced by it was milder and less hazardous.[169]

DEFINITION.

Vaccinia is an acute, eruptive disorder in man, caused by the inoculation of lymph, derived from a sero-purulent eruption sometimes met with on the teats and udders of cows, and known as cow-pox. The virus is propagated either by vaccinating from one person to another, or by similar cultivations in the bovine species. The lesions are one or more in number, according to the points of inoculation, and undergo changes similar to those observed in variola. It completes its course in about three weeks, and for several years renders the subject immune to small-pox. Although vaccinia has been the subject of diligent inquiry, its real nature has never been clearly set forth. The identity of the disease which appears on the teats and udders of milch cows, and that observed on the hocks of horses, known as the "grease," or "sore heels," has long since been known, but their relation to small-pox has, during the whole nineteenth century, evaded the most pains-

[168] Jenner (E.): "Inquiry into the Causes and Effects of Variolæ Vaccinæ" (London, 1798).

[169] "Report of the Royal Commission," p. 13.

taking research. It was formerly believed that foot-rot, or foot-and-mouth disease, met with in sheep, as well as an affection seen in monkeys, were identical with cow-pox, but the experiments of Hurtrel d'Arboval proved that they bear no protective relationship to each other, and that the two diseases are entirely distinct. As to the relationship between small-pox and cow-pox, the experiments of Depaul[170] led him to affirm that: "First, there is no vaccine virus. Second, the alleged vaccine virus which is regarded as antagonistic to the variolous virus is nothing less than the variolous virus itself. Third, the bovine and equine species are subject to an eruptive disease which is identical as regards its nature with small-pox in man." According to Depaul, therefore, horse-pox, cow-pox, vaccinia, and variola are identical affections, all having small-pox as their common source. This observer further states his belief that these affections are one and the same disease, which change in form and development, some developing completely, others incompletely, according as it affects one or the other animal; and, further, that the virus of one form of the disease may be changed into that of another, when it is transferred to the soil proper to the last. On the other hand, Chauveau and his colleagues of the commission appointed by the Society of Medical Sciences of Lyons, to ascertain by experimental methods the true relationship between small-pox and cow-pox, have endeavored to prove the absolute non-identity of variola and vaccinia. For this purpose thirty cows and heifers were inoculated with small-pox matter, which in not a single instance gave rise to the typical vaccine vesicle, although it produced a specific effect which the Committee reported was not cow-pox, but was of the nature of small-pox, although it differed from its manifestations as observed in man.[171] More recently Voigt,[172] King,[173] Hime,[174] and Simpson[175] have demonstrated that, by repeating the inoculation, the variolous matter produces in some instances a typical vaccine vesicle after the second generation, or in one or more removes from the human subject.

Viewed bacteriologically, Welch[176] regards vaccinia as a modified small-pox, changed in passing through the system of the cow. He further remarks that it has been proved again and again that small-

[170] Depaul: Bull. de l'Acad. de Méd., December 1 1863, *et seq.*

[171] "Comptes rendus de la Soc. Méd. de Lyon," tome v.

[172] Voigt. See Copeman: "Pathology of Vaccinia," in the "Twentieth Century Practice of Medicine," vol. iii, p. 640.

[173] King: "Trans. Southern Indian Branch Brit. Med. Assoc.," 1891, vol. iv, No. 1.

[174] Hime: Brit. Med. Jour., 1892, vol. ii, p. 117.

[175] Simpson: Indian Med. Gaz., May, 1892.

[176] Welch (W. H.): "Trans. Amer. Public Health Assoc.," 1889.

pox can be conveyed to the cow, young heifers being especially susceptible.

From the foregoing and from analogy we have reason to believe that small-pox and cow-pox are originally derived from a common source, and that small-pox may become modified in its transmission through the organism of the cow in such a manner as to produce vaccine virus; in other words, that the vaccine, as obtained from the cow, is a product of small-pox, modified in its transmission through another species.

SYMPTOMATOLOGY.

The ordinary phenomena observed after the introduction of the vaccine-virus may be given in the order of their appearance. At the point of inoculation nothing is usually seen excepting a slight redness, which usually subsides within a day or two, until the end of the third interval is called the PERIOD OF INCUBATION. On the morn- third or fourth day a distinct redness may be observed, which, ours, develops into pale-reddish papules at the seat of inocula- ing the fifth day the epidermis becomes raised by the collec- serous exudate, forming a whitish or bluish ring about the on, which thus presents a central depression, or umbilication. own as the PERIOD OF ERUPTION. This enlarges on the sixth rms a distinct vesicular projection above the level of the sur- skin. On or about the seventh day the underlying derma lt as a distinct indurated zone when grasped between the l finger. The vaccine lesion reaches its height on the eighth lay, when it is spoken of as mature, sometimes also as the SECRETION. It is stated by Mortimer[177] that the vaccinal ires more slowly in the African race, its development being ven to thirteen days. If the vesicle is ruptured at this time a ar, unctuous, or slightly gummy fluid escapes, although several punctures are necessary to evacuate the entire contents, which resembles that observed in the variola pustule and is due to the same anatomical conformation. At this time the lymph should be collected for future use. When the sac is left intact the vesicular contents soon assumes a turbid or opalescent appearance, and the lesion presents a rounded contour, which projects at the margin, while the top assumes a flattened or plateau-like surface. This stage is often called purulent transformation, or STAGE OF SUPPURATION.

[177] Mortimer: The Lancet, April, 1874, p. 219.

In size the pustule varies according to the surface exposure to the vaccine-virus, but usually attains a diameter of a quarter to half an inch (6 to 12 millimetres), and is accompanied by marked œdema of the surrounding structures. The neighboring lymphatic glands are often enlarged, and a rise of temperature of two or three degrees is not uncommon. At this time, too, the feeling of malaise, which usually accompanies the development of the lesion, now takes on a more pronounced form, and the patient may be indisposed or even ill for a day or two. This, however, soon passes away, and the œdema disappears, together with the umbilication and inflammatory areola. These symptoms are often observed to be less severe in children than in adults. On the tenth or eleventh to the fourteenth or fifteenth day the symptoms rapidly subside, constituting the PERIOD OF DESICCATION. At this time the lesion appears as a wrinkled, dry, brownish crust, which first develops in the centre of the lesion about the thirteenth day, and gradually takes on a blackish hue, shrivels at the margins, and drops off from the twenty-third to the twenty-eighth day. This final stage is called PERIOD OF CICATRIZATION. The scar left is at first red, but fades until a whitish, pitted (foveated) mark remains. According to Fürst,[178] there is an increase in the number of white blood-cells during the active period of vaccinia.

ANOMALOUS VACCINIA.

In many cases of vaccination the symptoms differ from the foregoing. This departure from the normal may depend either on the attenuation of the vaccine matter, on the resistance encountered, or on some peculiarity in the person vaccinated. There are few people who are not susceptible to vaccination. Spalding[179] reports a case in which he performed vaccination ten times before a successful result was obtained, while Garrot[180] made thirteen futile attempts before meeting with success. According to d'Espine,[181] the vaccinal immunity, or insusceptibility to the action of the vaccine virus, occurs in less than 1 per cent. of all cases. Neither age, sex, nor bodily condition, aside from a previous attack of variola or vaccinia, has any influence on the receptivity of the virus. The fœtus *in utero* is not affected by maternal vaccination. Thus, of 50 vaccinations of newborn children whose

[178] Furst: "Die Pathologie der Schutz-Pocken-Impfung" (Berlin, 1896), p. 21.
[179] Spalding (H.): Jour. Amer. Med. Assoc., 1899, p. 1230.
[180] Garrot (E.): Jour. Amer. Med. Assoc., 1899, p. 1230.
[181] D'Espine: "Vaccine," in "Dictionnaire de Méd. et de Chir. Pract.," 1885.

mothers had been successfully vaccinated during gestation at the Maternity Hospital at Lille, Dubequet[182] obtained 44 positive results.

In many cases of revaccination the vaccinal pocks do not follow the regular course previously described. This is influenced largely by the length of time which has elapsed since the previous vaccination. Thus, the period of incubation is subject to great variations, the pock sometimes appearing on the second day, at other times not showing itself until the seventh or eighth, or as high as the thirtieth day,[183] after inoculation. For this reason it is not infrequent that a physician vaccinates the second time, thinking the first has not been successful, when he observes the two eruptions appearing almost simultaneously.

VACCINOID, OR FALSE VACCINIA. — The eruption, or vaccine papule, as sometimes observed, fails to reach maturity. Both Trousseau (*loc. cit.*, pp. 121 *et seq.*) and Dumont-Pallier[184] have studied this condition and speak of it as bearing the same relation to true vaccinia that varioloid bears to variola. They believe, further, that it develops, like varioloid, on a soil which is not absolutely sterile, but unfit for the complete development of the inoculated virus. The former proposed to designate it false vaccine, or false cow-pox, a condition analogous to varioloid, and possessing immunizing power similar to that affection. Herviteux, in a communication to the Academy of Medicine of Paris in 1893, concurred in the opinion that vaccinoid transmits by inoculation true vaccine, and that consequently, like vaccinia, it confers immunity to small-pox. According to this observer, three types of false vaccinia may be observed, dependent on the degree of weakening of the virus or the amount of resistance encountered.

In the first type a pink papule appears at the point of inoculation, which is not accompanied by any marked inflammation, and disappears in the course of a few days, leaving no scar.

The second form is more active than the preceding. The papule is elevated above the surrounding skin, of a reddish color, and surrounded by a distinct areola. A small vesicle often forms on the summit of the papule, which desiccates, leaving a small crust, which falls off without producing a cicatrix.

The third type is still more severe, leaving a cicatrix, which finally disappears.

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[182] Dubequet. See Brouardel: "Vaccinia," in the "Twentieth Century Practice of Medicine," 1898, vol. xiii, p. 520.

[183] Brouardel (*loc. cit.*, p. 528).

[184] Dumont-Pallier: Gazette Hebd. de Méd. et de Chir., 1880, pp. 374-474.

These are all accompanied by slight itching, but no fever or other noticeable symptoms.

The writer has observed different degrees of vaccinoid, or false vaccinia, in revaccinating himself on two or more occasions, and looks upon it as the vaccinal eruption not infrequently observed when the operation is repeated at frequent intervals.

It is claimed that *vaccinia without eruption* may occur. Thus, Treluyer, with five other physicians of Nantes, in 1825 are reported by Brouardel (*loc. cit.*, p. 529) to have vaccinated 60 children during an epidemic of small-pox, who developed the constitutional symptoms of vaccinia without the appearance of any lesion at the seat of inoculation. A second vaccination resulted in neither general nor local symptoms. Further, it is claimed that in only 2 did small-pox occur, and they had not presented the constitutional symptoms observed in the others. To further test the protective influence thus acquired 5 children were inoculated with small-pox with a negative result, save a slight indisposition for about a week. These investigators regard it as analogous to *febris variolosa sine variolis* of Sydenham, and the *scarlatine fruste* of Trousseau, as well as that occasionally observed in other eruptive fevers without the appearance of the characteristic exanthem. Chauveau injected vaccine virus subcutaneously without producing any local manifestations.[185]

It is quite possible that a certain immunity may be acquired without the appearance of the typical pock, just as a mother cannot be inoculated from her child born syphilitic, although she may never have had the usual phenomena of syphilis. Such vaccinations, however, afford at best an uncertain protection, and it is difficult to say with any degree of assurance that the constitutional symptoms may not be due to extraneous toxic substances which have gained access to the wound, rather than to the specific effect of the vaccine-virus. In such cases, therefore, revaccination should invariably be performed.

SPONTANEOUS GENERALIZED VACCINIA is another infrequent condition which has been observed. According to Jeanselme,[186] this eruption must not be confounded with the general eruption due to auto-inoculation. As described by this observer, the eruption may ap-

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[185] **Chauveau:** "Vaccine et Variole" (Paris, 1865). "Tentations d'infection vaccinale par les voies respiratoires et par les voies digestives," etc. "Comptes rendu de l'Académie des Sciences," 1868. "L'injection de lymphe vaccinale dans le tissue conjonctif soucutane." Bull. de l'Acad. de Méd., 1860, p. 1334.

[186] **Jeanselme:** "De la Vaccine généralisée." Gaz. des Hôp., 1892, p. 253.

pear simultaneously with that at the seat of inoculation, and consists of lesions bearing a certain resemblance to the regular vaccinal pock. More frequently they appear about the seventh or eighth day, and develop more rapidly than the initial sore. The eruption varies in severity according to the individual peculiarity and may become either discrete or confluent. In the latter case death may occur. It is said to be common after accidental inoculation with cow-pox or horse-pox.

In the writer's experience, generalized vaccinia has always appeared after considerable inflammation and suppuration in the original vaccinal pock, and the strong supposition has always existed that pus was conveyed from the primary sore by means of the finger-nails or clothing. It is known that abrasions on the skin, such as observed in eczematous or pruritic subjects, predispose very strongly to generalized vaccinia.

COMPLICATIONS AND SEQUELÆ.

Of great importance are the concomitant disturbances of vaccination, because, by proper attention on the part of the physician or those responsible for the subsequent care of the patient, they may, for the most part, be wholly avoided. Medical men are often unjustly censured, while the patient is to blame for these attendant evils. There is, likewise, a tendency among the laity to look upon vaccination as the *fons et origo* of all subsequent ills. So loud was the clamor raised in England a few years ago that, next to the efficacy of vaccination as a protective agent against small-pox, the question second only in importance with which the Royal Commission had to cope was in reference to the objections made to vaccination on the ground of injurious effects alleged to result therefrom. It seems unnecessary to describe in detail or even enumerate the various affections that may be inoculated at the time of vaccination or be excited by neglect during the active period of the vaccinal eruption. Neither is it necessary to discuss the various objections alleged against vaccination, which may be found in the "Report of the Royal Commission," to which reference has previously been made. If the instructions which follow are strictly adhered to, the list of casualties will be exceedingly short. The most dire consequences may follow an abrasion or even the prick of a pin, if toxic substances gain access to the wound either at the time of its infliction or subsequently. Even greater care should be exercised in the practice of vaccination, and failure to direct, or neglect in carrying out, the ordinary principles of antisepsis should be ac-

counted a crime. By far the most frequent complications are due to the introduction of the ordinary pyogenic micro-organisms.

Erythema.—Not infrequently the areola described as encircling the normal vaccinal pock extends far beyond the seat of vaccination. In fact, many instances are recorded in which a general roseola extended over the entire body; more commonly, however, it is confined to the arms, upper part of the chest, and neck. Sometimes the eruption bears a striking similarity to scarlet fever or measles. Little or no constitutional disturbance can be associated with the appearance of this exanthem. It usually appears about the ninth or eleventh day, and gradually fades in the course of two or three days. Various theories have been advanced as to the cause of this eruption, and its analogy to the medicinal rashes has been discussed by Behrend and Brouardel (*loc. cit.*).

Eczema.—In those predisposed, eczema is liable to appear about the vaccinal lesion. The irritation and consequent scratching indulged in is liable to set up a vesicular or pustular dermatitis, which may persist long after the disappearance of the vaccine lesion. Eczema being comparatively common in childhood (the period usually selected for vaccination), this complication deserves more than a passing notice. That eczema may be induced in those whose skins have a feeble resistance to external irritants is a well established fact. Naturally the greater the irritation, the more liable is eczema to follow. Thus, with the development of the vaccinal lesion and its accompanying inflammation it is not strange that this complication should assume the importance which it occupies. From the records of many hundred cases of eczema observed by the writer, in not a single instance could the disease be attributed to the influence of vaccination alone. It has been found in many instances in which vaccination was the alleged cause that eczema had existed previously, even when absent at the time of vaccination. On the other hand, it has often been observed that eczema is intensified by vaccination, and a mild attack may thus be changed into a grave, generalized eczema. Moreover, greater danger exists, in subjects predisposed either to eczema or prurigo, of giving rise to a generalized vaccinia.

Generalized Vaccinia, Due to Auto-inoculation. — It is generally conceded that during the first week multiple inoculations are possible. Cory[187] succeeded in obtaining successful reinoculations on successive

[187] Cory (R.): "St. Thomas Hospital Reports," 1885, vol. xv, pp. 101-104.

days until the ninth day. The period of greatest immunity to revaccination is about the fourth week, although there are exceptions to this rule. Thus, Allbutt observed a woman who had not only had smallpox three times, but had also been three times successfully vaccinated.[188] This explains the many striking examples of generalized vaccinia on record. The eruption begins during the stage of secretion or suppurative stage of the pock, and is usually the result of scratching or otherwise rupturing the original lesion. The virus may then be conveyed to denuded parts by the clothing, or more commonly directly by the finger-nails, as in the act of scratching. In the case recorded by Acland (*loc. cit.*, p. 576) the eruption appeared on the face, arms, legs, abdomen, and thighs, assuming in places a confluent form, which resulted in the formation of large, open sores, and terminated fatally in the eighth week. More frequently the eyelids, nose, lips, or anal region are involved.[189] The lesions, therefore, vary from one or two to several hundred, and, in appearance, bear a striking resemblance to the original vaccinal sore, excepting that they often mature more rapidly and are prone to become pustular at a very early stage. The constitutional symptoms are generally well marked, although naturally they are largely dependent on the number and extent of the lesions. The striking and wide-spread appearance of this eruption gives rise to some difficulty in diagnosis. One should therefore bear in mind the possibility of autoinoculation in all cases of supernumerary pocks. In one instance of generalized vaccinia thus produced, which came under the writer's observation, not only were the constitutional symptoms severe, but the close resemblance to variola was a striking feature. The duration of the individual pocks, however, is shorter, and, when one is able to watch the method of extension and development of the eruption, its true nature may readily be ascertained.

Papillary hypertrophy, commonly called *red-raspberry excrescence*, is occasionally encountered. It usually begins to develop a few days after the insertion of the lymph, in the form of a red papule which increases in size, varying from that of a pea to a pigeon's egg. It sometimes remains several months, then gradually disappears. It is met, for the most part, in strumous subjects. The inmates of hospitals

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[188] Acland (T. D.): See "Vaccinia in Man," in Allbutt's "System of Med." (New York, 1897), vol. iii, p. 576.

[189] Felkin (R. W.): "Edinburgh Obstet. Trans.," vol. xvi, p. 807.

seem especially prone to this anomaly, as was observed recently in vaccinating the inmates of Lakeside Hospital.

Vaccinia Hæmorrhagica.—Cases of vaccinia hæmorrhagica are recorded by Gregory, Bergeron, and Barthélemy (Acland, *loc. cit.*, p. 578). They are met with in scorbutic or rachitic children, in whom the power of resistance is low. The hæmorrhage may be limited to the vaccine pustule, or more or less extensive areas may be covered with small, pin-head-sized petechiæ or subcutaneous ecchymoses. This complication, like many others, is probably wholly dependent on the general condition of the patient, and care should be taken in placing the recipient for vaccination in the best possible physical condition.

Erysipelas.—This is a danger incident to all open wounds or abrasions of the surface from whatsoever cause, and is, therefore, not peculiar to vaccination. According to the last "Census Report of the United States," the average death-rate from erysipelas to every 100,000 inhabitants, of all ages, was 16.47, while under five years of age it was 31.34 per 100,000. In a series of 100 cases of erysipelas Allen[190] found the point of infection in 50 per cent. to be some defect or abrasion of the skin. It is further known that erysipelas is especially common among the uncleanly. Thus, according to the "Louisville Health Reports,"[191] of the 79 deaths from erysipelas during the past ten years, 17 were in the colored race. As strong predisposing causes of erysipelas we have, therefore, age (under five years), an abrasion or wound of the skin, and uncleanly habits, all of which are furnished to a greater or lesser degree in the great majority of recipients of vaccination.

Further, erysipelas is now known to be due to a specific micro-organism, the streptococcus erysipelatosus of Fehleisen, which develops most readily in an irritated vaccinal lesion. As shown by Pfeiffer,[192] Crookshank,[193] Sternberg,[194] Landmann,[195] and others, vaccine lymph may contain, among various other micro-organisms, streptococci capable of producing erysipelas, although they are extraneous or accidental constituents; for the same observers have likewise shown that vaccine lymph which has been deprived of all known living pyogenic

[190] Allen (C. W.): Medical News, April 8, 1899.

[191] Quoted by H. W. Stelwagon: "Diseases of the Skin," in "Prog. Med.," 1899, vol. iii, p. 191.

[192] Pfeiffer (E.): Internat. klin. Rund., 1889, p. 72.

[193] Crookshank (E. M.): Evidence given to the Royal Commission, and "The History and Pathology of Vaccination" (London, 1887), vol. i.

[194] Sternberg (G.): Med. Record (New York, 1896), p. 677.

[195] Landmann: Hygienische Rund., 1895, p. 976, and 1896, p. 441.

organisms still gives rise to the characteristic effects of vaccination. Finally, Kitasato's[196] experiments go to prove that all inflammatory symptoms connected with vaccination are due to the presence of *extraneous pathogenic organisms* in the lymph.

It is clear from the foregoing that erysipelas, although common, is one of the preventable complications of vaccination, and may be avoided by using pure or sterilized lymph, and by excluding pathogenic germs from the wound.

Ulceration, Glandular Abscess, Septic Infection, Gangrene, and Tetanus.—When one considers the gross ignorance displayed by some in performing the operation of vaccination the wonder is that preventable complications and sequelæ are not even more frequently met with than statistics show them to be. It is to be hoped that, with a more general understanding of antiseptic principles, or at least the importance of cleanliness in all procedures in which the natural barriers to disease are removed, the conditions herein mentioned will become unknown. Much has been accomplished in this direction since the methods once in vogue, as portrayed by Creighton,[197] were in general use, as well as those practiced in the rural districts of America even in the writer's boyhood. Fortunately, it is no longer the custom to vaccinate from arm to arm without the services of a physician, and they no longer carry the vaccinal crust loosely in the vest-pocket. Little wonder that the small boy, with an intuition wiser than he knew, ran to the woods to escape the much-dreaded "sore arm." Yet it is not in the rural districts that the frightful consequences herein mentioned are most frequently observed. In the poor districts of cities and in asylums where the standard of health is reduced to a low ebb these complications are most common. Upon the condition of the tissues, therefore, and their variable resisting power depend mainly the phlegmonous and ulcerative changes described, although the exciting cause, as previously stated, depends upon the presence of extraneous excitants not necessarily associated with vaccination. Formerly, when humanized lymph was used more generally than at present, septicæmia due to contaminated lymph was more common. Pincus found evidences of decomposition and septic bacteria in the lymph employed at Crabnick in 1878, when, of 50 children vaccinated, several had an erythematous eruption, others phlegmonous swellings

[196] Kitasato: Sei-i-Kwai Med. Jour. (Tokyo), 1896, pp. 91 and 176.

[197] Creighton: "The Natural History of Cow-pox and Vaccinal Syphilis" (London, 1887).

and abscesses, and 15 died.[198] Brouardel (*loc. cit.*, p. 534) gives in detail an account of the appalling results following the use of vitiated virus at Asprières, in 1885. Of 42 children vaccinated, 6 died within twenty-four hours, and many others were dangerously ill. Investigation showed that the lymph used had gradually developed virulent properties by successive inoculations in the human subject, until the fifth cultivation gave rise to all the clinical phenomena of septicæmia. It is obvious, therefore, that great care should be taken in selecting the virus, and, when possible, only the sterilized lymph derived from the calf should be employed. Humanized lymph should never be used unless the preceding cultures have been under the care of a competent observer.

Impetigo sometimes follows vaccination, appearing about the end of the third week. It should, therefore, be regarded as a sequela rather than a complication. In the cases that have come under the writer's observation it has seemed to proceed originally from suppuration and copious pus formation in the original lesion, with the subsequent development of multiple suppurative foci in the immediate neighborhood. According to Payne,[199] pus micro-organisms increase in virulence by being cultivated in a focus of local inflammation, by having an abundant supply of oxygen, and by inoculating them from one individual to another. He has further observed that a series of such successive inoculations, especially if rapid, appears to markedly increase the virulence of most contagions. For this reason the local inflammation accompanying vaccinia when aseptic precautions are disregarded, gives rise to micro-organisms which, when inoculated successively from place to place on the body, or from individual to individual, as is not uncommon in crowded dwellings, develops virulent properties which result in sero-purulent lesions, which spread rapidly, both at the periphery and from place to place, until the whole cutaneous surface is more or less involved. Some of the severest concomitants, or more correctly sequelæ, of vaccination are those of generalized bullous dermatitis. (Plates XXI and XXII.) Bowen[200] has reported five cases of bullous dermatitis which appeared from one to four weeks after vaccination. In these cases the localization of the lesions was a conspicuous feature, it having a marked tendency to

[198] Pincus: "Die Impfung in Crabnick." Vierteljahresschrift für Gerichtl. Med., etc., July, 1879.

[199] Payne: The Lancet, July 4, 1896.

[200] Bowen (J. T.): "Trans. of the Amer. Derm. Assoc.," 1900; also in Jour. Cut. and Genito-Urin. Dis. (New York), August, 1900, p. 344.

PLATE XXI.

Bullous Eruption following Vaccination.

PLATE XXII.

PLATE XXII.

Same as the Preceding, showing Feet and Ankles.

group about the mouth, chin, nose, and ears, and upon the backs of the hands and feet. In addition, the extensor aspects of the extremities were, in general, more prominently affected, while the trunk was but slightly affected as compared with other regions of the body. Such cases are liable to be confounded with pemphigus. It has been the writer's fortune, as well as misfortune, to be called upon to decide between the medical attendant and the patient's family relative to placing the responsibility in cases of what seemed to be the bullous variety of impetigo. When sterilized virus has been used, the parts properly prepared, and suitable instructions given as to the proper care of the case, with the request that he be allowed to inspect the patient once or twice thereafter during the first week, the medical attendant's responsibility ceases.

Psoriasis.—The cause of psoriasis is unknown, but certain observations concerning its appearance lead one to believe that there is an underlying condition that predisposes to or offers a suitable soil for the development of the disease. We know, further, that in certain persons the skin exposed to the pressure and friction of suspenders, skirt-bands, hat-bands, and garters becomes the primary seat of the psoriatic eruption. In fact, it may remain well-nigh limited to these parts. It is a matter of common observation that psoriasis usually first appears, and is the most persistent, on the tips of the elbows and knees: parts most exposed to the constant irritation of the clothing. Furthermore, it is not unusual to hear psoriatic patients say that at the onset of an attack every scratch or abrasion inflicted on the sound skin gives rise to a psoriatic patch. With these observations before us it is not surprising that occasionally psoriasis appears after vaccination. In two cases of psoriasis during the past year the cause assigned by the family was vaccination, because the eruption first made its appearance at that time. A moment's consideration will enable one to appreciate the etiological influence of vaccination in psoriasis, because we know that pressure, friction, irritation, or vaccination will not of themselves give rise to the disease. However strongly these determining or exciting influences may appear to be the real cause, there still remains an essential something of which we are at present ignorant.

Tuberculosis.—The experiments made by Besnier,[201] Bollinger,[202]

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[201] Besnier (E.): "Lupus Vaccinal," Ann. de Derm. et de Syph., 1889, p. 576.

[202] Bollinger: "Ueber die Infectionswege des tuberculosen Giftes." Münchener med. Woch., 1899, p. 567.

and Strauss[203] leave us in doubt as to the possibility of inoculating the tubercle bacillus in the process of vaccination. From clinical observation[204] it seems highly probable that tuberculosis may be inoculated in the skin; at the same time, it is only possible when the tissues furnish a favorable culture-medium, such as is observed in struma and other debilitated conditions. The clinical forms of tuberculosis vary in different cases; in strumous children, indolent, phlegmonous swellings, abscesses, and ulcers are sometimes met with. Talcott Fox and Acland have observed lupus vulgaris develop in vaccination scars (Acland, *loc. cit.*, p. 622), although in neither instance was the source of the affection known. No proof, therefore, exists that lupus attacks vaccination scars more frequently than it does those resulting from other causes. Moreover, it is of great importance that the subject for vaccination be placed in the best possible health, and especially does this apply to those who are predisposed to tuberculosis: a condition commonly denominated scrofula.

Syphilis.—Much has been written on the subject of syphilis due to vaccination, and without question it is a sequela against which the medical man should constantly be on guard. Formerly when humanized lymph was used it was a far greater source of danger than it is now. No one who has had much to do with syphilis pretends to be able to select from a group of children in any public establishment those free from syphilis, yet the writer was so taught and expected to do in an East London vaccination station twenty years ago. It is true that cases of syphilis even then were rarely indeed encountered, and the writer has never observed syphilis thus contracted. Only by the strictest care, however, can this be obviated with the system of arm-to-arm vaccination or in selecting lymph as herein mentioned. It is well known that blood from a syphilitic source will give rise to syphilis when inoculated into a non-syphilitic subject, but it is not positively known that the disease can be communicated by injecting the clear vaccine lymph obtained from a person, even when contaminated with syphilis. On the contrary, the experiments of Husson, Bousquet, and Steinbrenner (quoted by Brouardel, *loc. cit.*, p. 538) prove that lymph taken from a syphilitic subject may be inoculated in a susceptible person without communicating syphilis, while Vien-

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[203] Strauss: "La tuberculose, est elle transmissible par le vaccin?" Soc. Méd. des Hôp., February 13, 1885.

[204] The author: "Lupus Vulgaris following Exposure to Tuberculous Sputa." Jour. Cut. and Genito-Urin. Dis. (New York), April, 1893.

nois[205] demonstrated conclusively that syphilis may be transmitted by vaccination. Brouardel (*loc. cit.*, p. 541) describes an epidemic of syphilis due to vaccination which occurred at Rioalta in 1861, in which virus from a syphilitic child was used in vaccinating 46 healthy children. One of these children served as vaccinifer for 17 other children, making 63 in all, of whom 46 were infected with syphilis: 39 of the first series and 7 of the second.

Moreover, it is difficult to arrive at a correct conclusion on the subject of invaccinated syphilis. Many cases thus reported rest on doubtful evidence, while others are reported from hearsay alone. This was clearly pointed out in the investigations of the Royal Commission, which found that of all cases of syphilis alleged to be due to vaccination occurring between the years 1889 and 1896, when subject to a searching inquiry, not one could be proved to be syphilis. During this time the whole number of vaccinations in Great Britain approximated six millions. The experiments made by Cory[206] on himself are instructive in this connection. This investigator purposely vaccinated himself with lymph taken from a syphilitic child. The vaccination was unsuccessful, the lesions maturing early and falling off about the fourth or fifth day. No evidence of syphilis followed. About two years later he again vaccinated himself with lymph taken from a patient known to be syphilitic, with a negative result both as to the syphilis and vaccinia. The experiment was again made about eighteen months later with a like result. In the fourth experiment the lymph was taken from a child contaminated with congenital syphilis. The common symptoms of congenital syphilis, such as snuffles, thrush, etc., had been observed, and there was still present a cutaneous syphilitic eruption. No syphilitic lesions were situated in the vicinity of the vaccine-vesicles, which were normal in appearance and not inflamed. They were shallow and difficult to open without drawing blood, although the utmost care was taken that no admixture of blood should take place, and the lymph was collected on a clean instrument. Three insertions were made, and aside from an erythema which disappeared in about a week, they presented no unusual symptoms. On the twenty-first day, however, there appeared a slight disturbance in two of the points of inoculation, one of which developed into a typical chancre

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[205] Viennois: "Transmission de la Syphilis par la Vaccination." Archiv. Gén. de Méd., July, 1860.

[206] Cory (R.): "Report of the Royal Commission," p. 244.

and was followed in due time by other symptoms of syphilis. In this connection it may be said that, according to the observation of Husband,[207] of Edinburgh, lymph, although collected with the greatest care, and however pellucid it may appear, still contains blood-cells to a greater or lesser degree. That syphilis is seldom communicated in the process of vaccination is proved by the fact that Lee[208] has seen but 1 case of supposed vaccinal syphilis among 30,000 children at the Great Ormond Hospital, London; while Crocker,[209] than whom a more competent and painstaking investigator does not exist, has never encountered a case of invaccinated syphilis during his many years' service at the East London Hospital for Children.

In commenting on the frequency of invaccinated syphilis the commission previously referred to says: "As regards the almost infinitesimal risk of syphilis, . . . the evidence offered to us would lead to the belief that, while, with ordinary care, the risk of communication of syphilis in the practice of arm-to-arm vaccination can, for the most part, be avoided, no degree of caution can confer an absolute security. The rejection as vaccinifers of young infants—say, below four months of age (in whom congenital syphilis may be, as yet, undeclared)—and of adults (in whom the disease may possibly have been recently acquired) are precautions which would probably shut out almost the whole of the risk. The outbreaks of syphilis in connection with vaccination which have been mentioned to the commission (all of which had been previously published) have occurred chiefly in arm-to-arm vaccination among soldiers, or from the use, as vaccinifers, of young infants the offspring of parents whose history was not known to the vaccinator. It must, however, be admitted that neither the examination of the vaccinifer, if taken alone, and without a knowledge also of the parents, nor the most scrupulous avoidance of any visible admixture of blood with the lymph, are in themselves, however valuable, sufficient absolutely to exclude risk."

Thus far we have considered only arm-to-arm vaccinations, or those made with humanized virus. It is instructive to turn to statistics collected in Germany, where lymph direct from the calf is used almost exclusively. Under this condition, during the years 1889 to 1893, not a single case of invaccinated syphilis was reported.

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[207] Husband: "Report of the Royal Commission," p. 244 (New Sydenham Society).
[208] Lee: *Ibid.*, p. 241.
[209] Crocker (H. R.): Supplement to the "Thirteenth Annual Report of the Local Government Board," 1882, pp. 45-46.

PLATE XXIII.

XXIII

VACCINATION in a patient recently infected with syphilis; showing a generalized macular syphilide and an ulcerated vaccinal lesion with local secondary pus infection.

From the foregoing it is clear that exaggerated reports relative to the frequency of syphilitic invaccination have, from time to time, been made, and it must be acknowledged that its occurrence is one of great infrequency. When bovine virus is employed, the possible infection of syphilis need not be taken into consideration.

Leprosy.—In countries where leprosy prevails the possibility of communicating the disease by vaccination must be considered. Much that has been said of syphilis applies, although in a less degree, to leprosy. Thus far attempts to inoculate leprosy in non-leprous subjects have failed. A Norwegian physician,[210] about forty years ago, attempted to communicate leprosy, both to himself and others, by introducing under the skin leprous tubercles, blood and pus, with a negative result. Profeta[211] failed in like manner, as did Cagnina.[212] Köbner[213] and Hansen[214] failed to inoculate monkeys, as have Kaurin,[215] Rake,[216] and others.

To ascertain the possibility of transmitting leprosy by vaccination Bevan Rake and Buckmaster[217] vaccinated eighty-seven lepers in the Almora Asylum at Trinidad. Their report may be given in full as follows:—

"Of the 87 vaccinated, 40—21 males and 19 females—developed vesicles, which were examined.

"Of the 40 cases,
34 were anæsthetic.
5 were mixed.
1 was tuberculated.

"The condition of the skin where vaccinated was as follows:—
In 14 cases it was normal.
In 13 cases there was an anæsthetic patch.
In 12 cases sensation was diminished.
In 1 case there was tuberculation.

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[210] "Appendix 1, Report of Leprosy Commission" (London, 1893), pp. 432 *et seq.*

[211] Profeta: "Sur l'Elephantiasis des Grecs." Giorn. intern. dell. Sci. Med., 1884.

[212] Cagnina: Quoted by Leloir: "Traité Practique et Theorique de la Lepre" (Paris, 1886).

[213] Köbner: Virchow's Archiv, 1882, vol. xxxviii, p. 282.

[214] Hansen: Congress Med. de Copenhague, 1884, Comptes rendu.

[215] Kaurin: Jour. of the Leprosy Invest. Com., No. 2, 1891, p. 68.

[216] Rake (B.): "Reports of Trinidad Leper Asylum," 1884 to 1889.

[217] Rake (B.) and Buckmaster (G. A.): "An Inquiry into the Question of Communicability of Leprosy by Vaccination." Jour. of the Leprosy Invest. Com. (London), 1891, No. 4, pp. 33 and 34.

"The condition of the vesicles was as follows:—

In 31 cases normal.
In 2 cases purulent.
In 2 cases purulent and mixed with blood.
In 1 case normal on the one arm and purulent on the other.
In 1 case normal, but mixed with blood in taking.
In 1 case immature.
In 1 case immature and mixed with blood in taking.
In 1 case immature and the crust taken.

"Crusts also were taken from two vesicles which had been normal.

"Ninety-three cover-glasses were prepared, and in no case were undoubted leprous bacilli found. Suspicious looking rods taking fuchsin were seen in 1 case in vesicles raised over tuberculated areas, and in another case in vesicles over anæsthetic patches. Even if one were to consider these cases positive, and give them their utmost value, they would have little or no bearing on the question at issue, for no vaccinator would be likely to vaccinate a leper over a tubercle or anæsthetic patch, and use the lymph obtained from such vesicles for vaccinating healthy individuals.

"It is, therefore, the opinion of the writers that, assuming the presence of bacilli to be necessary to produce leprosy, this series of observations—the most extensive yet made—goes to show that no danger need be apprehended from the vaccine lymph or even an actual leper, provided he is vaccinated on apparently normal skin. *A fortiori*, therefore, there is no danger of transmitting leprosy by using as a vaccinifer a child born of a family in which leprosy exists."

From the foregoing it may be readily inferred that there exists only a remote probability of communicating leprosy from a vaccinifer to a vaccinee; no physician would, however, think of obtaining lymph from such a source. Until further light is obtained on the propagation of leprosy it is advisable in leprous countries to use vaccine lymph from the calf, or, at least, that obtained in non-leprous countries.

Viewing the complications and sequelæ of vaccination as a whole, we are forced to admit that an infinitesimally small number are to be looked upon as unavoidable, and necessarily connected with the practice of vaccination. Most of the diseases alleged to be invaccinated are really introduced by extraneous circumstances, or are the result of a natural tendency or constitution rather than from any inherent property of the vaccine virus. To more forcibly illustrate what may

be reasonably expected with approved modern methods of vaccination the experience of Voigt,[218] of Hamburg, may be cited. In 100,000 vaccinations performed during the past five years there occurred 1 case of axillary abscess and 2 others, the locality not given; 1 of furunculosis; 2 of erysipelas, and 5 vaccinal ulcerations, with 1 death (Acland, *loc. cit.*, p. 600). With the plentiful supply of sterilized lymph prepared under strict aseptic conditions, taken directly from the calf, there is no reason why Voigt's results may not be more generally obtained.

VACCINE VIRUS: ITS SELECTION AND PRESERVATION.

Humanized lymph, either for immediate or future use, should be selected from healthy children whose antecedents are known, and who present a typical, normal, primary vaccine vesicle, having translucent or slightly opalescent contents. As previously stated, this is usually met with about the seventh or eighth day. Unduly severe or inflamed pustules should be rejected. The lymph should, for the same reason, be drawn before the formation of the areola. The age most desirable varies from six months to eight or ten years. No one should be intrusted in procuring lymph who is not thoroughly familiar with the principles of asepsis and appreciates, in a high degree, the essential habit of cleanliness. Therefore all instruments and appliances should be sterilized by heat, carbolic acid, absolute alcohol, or some other potent germ-destroyer. After being thus treated they should be rinsed in sterilized water and dried. Before opening the vaccine vesicle the parts should be carefully cleansed by means of a boric-acid solution or other mild antiseptic, which should be followed immediately by copious flushing with sterilized water. This latter is important, as the lymph is rendered inert by contact with even a mild solution. If these precautions are not carried out, pathogenic organisms are liable to gain access to the lymph collected, rendering it liable to result, when used, in a mixed infection. The best receptacle is a fine glass tube, not more than a twenty-fourth of an inch (1 millimetre) in diameter and about two and a half inches (6 centimetres) in length. An opening is made in the upper third of the vesicle by a lancet and one end of the tube inserted. The lymph flows in by capillary attraction, and when about two-thirds full the ends are hermetically sealed by holding them for a moment in the flame of a spirit-lamp or Bunsen burner. The

[218] Voigt: "Ueber Impfschaden." Wiener med. Presse, 1895.

empty end should first be thrust in the flame which forms a vacuum, drawing the contained lymph away from the opposite end, which may then be sealed, without injuring the lymph, by heat. Several punctures may be necessary to evacuate the contents of the vesicle, but care should be taken that the base of the pock is not disturbed, lest blood be mixed with the lymph. No harm can come from healthy blood-cells, but, as previously shown, there is sometimes a possibility of their harboring pathogenic organisms, especially syphilis. The tubes should then be kept in a cool, dark place for future use. Formerly the virus was preserved by dipping lancet-shaped points of ivory, bone, or celluloid into the lymph and allowing them to dry. The danger of their becoming septic and their more rapid deterioration has caused them to be well-nigh discarded. Preserving the crust as it becomes detached, likewise in vogue at one time and still sometimes in use among the laity, cannot be recommended for the same reason. It is claimed that it retains the active principle longer than other forms. Humanized virus, once thought to be less severe and more certain of resulting in a successful vaccination, is now used only in emergencies when bovine lymph cannot be obtained. It deteriorates most rapidly when exposed to the light, and in a temperature above 70° F. (21.1° C.).

Bovine Lymph.—At the beginning of the nineteenth century public opinion was not prepared for bovine vaccination, and the most senseless, though ludicrous, notions as to its effects were entertained by the people. (Plate XXIV.) Hence, arm-to-arm vaccination became generally practiced. Not so in Italy, where Troja, of Naples, regarding vaccinia as an affection natural to the human race, deteriorated in successive cultures, inoculated heifers in 1804 in order to maintain a supply of efficient vaccine virus. Four years later Galbiata,[219] a student of Troja, advocated bovine lymph because it possessed a more decided action without greater danger, and was in no way less protective than humanized virus. He further maintained that it offers an advantage in that no other disease can be communicated thereby. According to Brouardel (*loc. cit.*, p. 546), animal vaccination in Paris was first proposed by James, although it met with little encouragement. The rapid strides made in bacteriology, however, during the last decade or two, have enabled us to eliminate many hitherto unsuspected sources of disease, and accordingly animal or bovine vaccine virus has lost its former terrors. As prepared to-day at several well

[219] Galbiati (G.): "Memoria sulla inoculazione collumore ricavato immediatamente della vacca precedentemente inoculata" (Naples, 1810).

PLATE XXIV.

"The Cow-pox, or the Wonderful Effects of the New Inoculation." Distributed by the Antivaccine Society of London. (From an Old Print in the Author's Collection.)

appointed establishments for the propagation and collection of vaccine lymph in the United States, animal virus is not only as mild, but equally as sure of "taking," as that of one or more removes in the human subject.

For many years bovine lymph preserved in glycerin has been in general use in Germany and Belgium. Chambou, Ménard, and Strauss[220] first demonstrated the sterilizing effect of glycerin. To the latter, especially, we are indebted for a series of carefully conducted experiments, in which it was shown that cultures made from fresh lymph, either alone or mixed with glycerin, gave rise to colonies of various microbes, such as the staphylococcus pyogenes aureus and albus, while lymph mixed with glycerin and allowed to remain ten days contained fewer; and, at the end of fifty or sixty days, cultures showed the virus to be sterile. This proved conclusively that glycerin was not only a convenient vehicle in which to preserve vaccine lymph, but of great importance in rendering it sterile without impairing its specific virus. This was supposed to be due to its effect in preventing putrefaction of the organic substances contained in the lymph, thus destroying the ordinary saprophytes, while the essential principle, or virus, was preserved. Other observers—among whom may be mentioned Klein,[221] Leoni,[222] and Kinyoun[223]—have confirmed these observations, and further demonstrated that other pathogenic microorganisms, such as the tubercle bacillus and the streptococcus of erysipelas, may be destroyed in like manner when exposed a few weeks to the action of glycerin. In this country bovine lymph has gradually come into general use, and is now the only recognized commercial form. In cultivating and collecting it the same careful procedures previously described are necessary. Specially prepared stables, rendered as nearly aseptic as possible, and laboratories for inoculating and sterilizing are among the necessary features. Although tuberculosis is seldom encountered in calves, yet it is advisable either to inject tuberculin preceding the inoculation or, better, after collecting the lymph, that the calf be killed and a careful examination made by one skilled in pathology to ascertain if the animal is free from tuberculosis or other communicable disease. Calves should be selected that have been weaned, preferably from four to six months old, and kept in a

[220] Chambou, Ménard, and Strauss: Gaz. des Hôp., December 15, 1892.

[221] Klein (E.): Report of medical officer to the Local Government Board (London, 1892).

[222] Leoni: Revue d'Hygiene, August 20, 1894.

[223] Kinyoun: Medical News, February 2, 1895.

separate stable for some weeks to eliminate, so far as possible, any potent source of infection, such as aphthous fever, pleuro-pneumonia, etc. After this stage of probation the animal is carefully scrubbed with potash soap and water, when it is placed in the inoculating stable. This should be constructed in accordance with the most approved plans, with cement floors and walls that may be washed frequently with a disinfecting solution, and care should be taken that the most scrupulous cleanliness as to bedding and other details is maintained. In short, the same care is here required that is necessary in a hospital operating-room. The animal is placed and securely fastened on a specially constructed table and the abdomen then shaved from the umbilicus backward, including the inner surface of the thighs. This shaved area is first scrubbed with soap and warm water and then washed with a solution of corrosive sublimate (1 to 2000). The parts are finally rinsed with sterilized water, which must be thoroughly done, for reasons previously given, and the inoculations are thickly made over the prepared region. The animal is then released, although care must be taken to protect the vaccinated area from being licked or molested in any way. About the seventh day the calf is again placed on the table and the lymph drawn. Light pressure by means of the blades of a forceps may be necessary to expel the lymph. Copemann recommends that the lymph be obtained at the end of ninety-six hours, by means of a steel spoon in which the epithelium and underlying vesicular pulp are removed, avoiding, as far as possible, the admixture of blood. To this is added four times by weight of a sterilized mixture of 50-per-cent. chemically pure glycerin and water, and the whole ground to a fine pulp, which may be preserved in the usual way. To preserve the lymph it must be kept away from the light, in a cool, even temperature ranging from 40° to 60° F. (4.4° to 15.5° C.).

PRACTICE OF VACCINATION.

Experience has shown that vaccination may be performed at any age. In many foundling institutions in France the child is vaccinated when a few days old, and, according to Brouardel, no ill effects are noticed. In England the age-limit for compulsory vaccination is three months and in Scotland six months. In general, with the presence of small-pox in the neighborhood, or when traveling, the child may be vaccinated at any age should occasion require. When not urgent, it may be deferred until after six months. It is usually best not to vac-

cinate during weaning, teething, change of diet, excessive heat, etc., which may affect the general health of the child. Likewise, when debilitated, or during the progress of, or convalescence from, any disease, it may be postponed unless urgently called for. Vaccination should, if possible, be avoided when erysipelas is in the home, when scarlet fever or measles is in the neighborhood, or when the child is afflicted with any acute disease of the skin, such as eczema or impetigo.

The arm is usually selected at the insertion of the deltoid muscle, although, in girls, the leg may be preferred on account of the disfiguring scar which is liable to follow. The parts should then be bared, care being taken that the clothing does not constrict free circulation, and scrubbed with potash soap and hot water and dried with a sterilized towel. When the surroundings call for additional precautions, the washing may be followed by alcohol or ether. After the use of alcohol or ether as a detergent the arm must be thoroughly flushed with sterilized water (water having previously been boiled), to obviate the danger of sterilizing the lymph. When dry, the epidermis should be torn up by means of a needle, previously passed through the flame of a spirit-lamp or Bunsen burner, until a serous exudate occurs, or at most but a faint trace of blood. It is advisable to expose an area of about half an inch in diameter (1.2 centimetres) to the action of the virus, which may be divided into two or more denuded areas. When multiple, they should be fully one and a half inches (4 centimetres) apart, to obviate the merging of their margins in case of pus-infection or when otherwise irritated. The content of one tube is then scratched into the denuded surface and allowed to dry, after which it should be covered with sterilized cotton-wool, to protect against contamination, and held in place by adhesive straps or better painted with flexible collodion. In general, the larger the vaccinal scar, the greater the protection from small-pox. This was clearly shown in the findings of the Royal Commission, and is the common observation of clinicians, although the writer agrees with Welch (W. M., *loc. cit.*) that the quality, as well as the quantity, of lymph absorbed should be taken into account. It is advisable that the medical man should inspect the arm on or about the fifth, and again on the seventh or eighth day, and at least once thereafter, usually about the eighteenth day. In primary vaccination, when urgent, the operation should be repeated if at the end of from a week to a fortnight no symptoms of a successful vaccinal pock appear. When no special danger of infection exists, it is advisable, especially in very young infants, to defer revaccination for a month, or until the effects of the first have wholly passed away.

CHAPTER IV.

VARICELLA.[224]

(Chicken-pox,[225] formerly, water-pock, glass-pock, swine-pox, etc.; German, *varicellen, wasserpocken, windblättern, schafpocken*; French, *varicelle, la vérolette*; Italian, *morviglione, ravaglione*; Latin, *variola notha seu spuria.*)

DEFINITION.

VARICELLA is an acute, specific, mildly infectious eruptive disorder, met with in childhood, characterized by a cutaneous exanthem of vesicular type, which comes out in successive crops, and is accompanied by mild febrile symptoms. The eruption terminates by desiccation and the formation of superficial crusts in from three to five days. One attack confers immunity for the rest of life. Although resembling variola in some particulars, it has no relation to that disease.

That the Arabians were familiar with varicella seems highly probable (see page 11). Be this as it may, it is unquestionably true that the disease was again lost sight of for many centuries (see page 18), and seems not to have been accurately described by Sydenham, although Rivière[226] gave a clear description of the disease as it appeared in France in 1641. A few years later, however, Morton (1690) described several cases under the title *variola maxime benigna*, which was probably the first clinical description of the disease in England. Harvey, in 1696, likewise contributed to the literature of this subject (Thomas). According to Gregory,[227] the term "chicken-pox" was introduced by Morton at this time.[228] Half a century later Fuller[229] (1730) attempted in unmistakable terms to separate it from variola, with which it was apparently inextricably confounded. The quaint, though forcible, logic employed by this writer in asserting the doctrine of the duality of variola and varicella has never been sur-

[224] Formerly sometimes written varicellæ, diminutive of *varus*, a pimple or pock.

[225] Probably derived from the Latin, *cicer*, or the French, *chiche*, insignificant.

[226] Rivière: "Prax. med." (Lugd., 1660).

[227] Gregory (George): "Theory and Practice of Physic" (Philadelphia edition, 1829), vol. i.

[228] Morton (R.): "Opera Medica" (Amstelodami, 1696), tome iii, p. 58.

[229] Fuller, quoted by Gee (S. J.), under "Varicella," in Reynolds's "System of Medicine" (London, 1870), vol. i, p. 217.

passed in more classic words: "The pestilence can never breed the small-pox, nor the small-pox the measles, nor the crystals or chicken-pox, any more than a hen can breed a duck, a wolf a sheep, or a thistle figs; and consequently one sort cannot be preservative against any other sort."

Varicella seems to have first been described in Germany by Sennert[230] in 1676, although this description is somewhat ambiguous, while the term varicella was first applied to this disease by Vogel[231] in 1764. At this time the disease attracted wide attention because of its mild nature, contrasting strongly with its formidable rival variola, which raged with appalling consequences. The next writer of note was Heberden,[232] who forcibly contended for the duality of variola or varioloid and varicella. For fully fifty years his work was looked upon as the leading authority, and unquestionably did more to enable physicians to differentiate between small-pox and varicella than any previous or subsequent writer of the eighteenth century. Next came Frank,[233] of Vienna, who, in 1805, made important contributions to the literature of the disease. He was followed by Heim,[234] of Berlin, although much confusion crept into literature by the various synonyms and errors made by different observers in distinguishing between mild cases of variola and varicella. Heim called attention to the non-inoculability of varicella, and mentioned other distinguishing features. He likewise dwelt upon the superficial character of the lesions, and the strong contrast shown to the deep-seated pocks of variola, which to-day we emphasize as one of the most valuable points in differentiating between them. No writer, however, entered into the minute appearances of the two eruptions, nor gave a clearer description of the disease itself than did Wilan in 1806. He spoke of the peculiar "lenticular," "conoidal," and "globate" forms of the lesions.

With the general introduction of the practice of vaccination at the beginning of the nineteenth century many more cases of variola became so modified as to present even a closer clinical appearance to varicella, which added to the confusion already experienced. This, it may be remarked, continues in some not very remote parts of the globe

[230] Sennert: "Opr. Omn. in-fol" (Lugduni, 1676). *Vide* Rayer (Paris, 1835), vol. i, p. 564.

[231] Vogel (R. A.), 1772. *Vide* Bohn, in Gerhardt's "Handbuch der Kinderkrankheiten" (Tübingen, 1877), p. 325.

[232] Heberden: "Transactions of the Royal College of Physicians"; also "Commentaries on the History and Cure of Diseases" (Boston edition, 1818), vol. i, p. 427, 1767.

[233] Frank: "Traité de méd. pratiq.," trad. par Goudareau, 8 (Paris, 1820), tome ii.

[234] Heim: In Horn's Archiv für praktische Medicin und Klinik., B. 7, H. 2, S. 183.

to the present day. It is not strange, therefore, that a wide difference of opinion existed as to the identity and non-identity of the two affections. During the years 1818-19 an epidemic of what was supposed to be chicken-pox prevailed in Scotland, which was reported by Thomson,[235] of Edinburgh, who further retarded the process of differentiation by affirming that varicella was only a mild manifestation of the variolous poison. He was followed by Hebra, of Vienna, who, for nearly a half century expounded the belief that varicella was but a modified form of variola. Probably no author of wide clinical experience at the present day doubts the non-identity of the two diseases, and, like the final differentiation and establishment of rubella, varicella has gradually emerged from the state of confusion in which it has for centuries existed, and through the slow process of evolution in medicine is now almost universally regarded as a specific and distinct disease.

SYMPTOMATOLOGY.

Latent Stage, or Period of Incubation.—This varies from ten to nineteen days, although it is usually conceded to be most frequently fourteen days from the time of exposure to the appearance of the rash. Thomas found it approximately from thirteen to seventeen days, and somewhat longer than in both variola and morbilli. This agrees with the period given by Gee,[236] Trousseau (*loc. cit.*, p. 136), and Hesse,[237] although shorter periods have been reported by Sykes[238] and others. Steiner[239] found the period of incubation after inoculation to be uniformly eight days in eight cases, while MacCombie[240] gives ten days as the usual period after inoculation. The period of incubation, therefore, is about the same as observed in variola. During this time no symptoms are apparent.

Prodromal Stage.—In may cases during this time no evidence of infection is present; at least no symptoms are observed before the appearance of the eruption. In 50 per cent., or 4 of Steiner's cases, mild febrile symptoms were observed, and in 4 no disturbance whatever occurred before the eruption appeared. Properly speaking, therefore, there is, in a large number of cases, no prodromal stage. At times, however, it is noticed that the child is restless and fretful, again

[235] Thomson (John): Edinburgh Med. and Surg. Jour., 1818, vol. xiv, pp. 518-657.
[236] Gee: "Varicella," in Reynolds's "System of Medicine" (London, 1870), vol. i.
[237] Hesse: "Ueber Varicellen," etc. (Leipzig, 1829).
[238] Sykes: Brit. Med. Jour., 1899, i, p. 81.
[239] Steiner: Wiener med. Woch., No. 16, 1875.
[240] MacCombie: Allbutt's "System," article "Chicken-pox" (*op. cit.*).

dull and apathetic, a few hours—or it may be a day or two—before the eruption appears. Of 43 cases in which careful notes were taken by the writer, 19 showed no premonitory symptoms, nor could any rise of temperature be detected; in 24 there were mild febrile symptoms present to a greater or less degree, among which were slight anorexia in 20, irritability in 17, lassitude in 10, headache in 4, slight pain in the back and limbs in 2, chilliness in 9, nausea in 4, and vomiting in 2. These premonitory symptoms were of short duration, and varied from two to thirty-six hours immediately preceding the eruption. In most of these cases there was a slight rise of temperature the evening preceding the first crop of lesions, which were visible on the following morning or during the day. In 27 cases Hyde[241] failed to observe any premonitory symptoms. From further observation in asylums and similar institutions I believe that it is not uncommon to detect a slight rise of temperature a few hours preceding the rash. This is never high, ranging from 99° to 102° F. (37.2° to 38.8° C.), nor of long duration, and sometimes ends with the outbreak of the exanthem. A higher temperature should be looked upon with suspicion, lest it forebode a more serious affection.

In private practice the most watchful mothers usually detect no derangement in the usual health of the child before the rash appears, and in but few instances has the writer ever observed serious disturbances which could be attributed to the poison of varicella. All writers on varicella ascribe considerable diagnostic importance to the absence of fever and prodromal symptoms. According to Heberden, they are absent or slight; no symptoms are noticed before the eruption, says Gregory. The same opinion prevails among more recent authors, while many cite numerous exceptions to the rule. Liveing says the premonitory symptoms are often very slight, indeed, or not observed at all, while sometimes they are well marked. Holt says that rarely for more than half a day and in many cases no prodromata whatever are noticed, the rash being the first thing to attract attention. This view is likewise held by MacCombie. Henoch[242] believes it is the rule for the exanthem to appear without any prodromal symptoms, and only a few times before the eruption appeared has he observed headache, vomiting, or fever, and still more rarely a slight conjunctivitis or angina. In one instance a copious prodromal rash occurred, with high fever and con-

[241] Hyde (J. Nevins): "Varicella," in Pepper's "System of Med." (Philadelphia, 1885).

[242] Henoch: "Vorlesungen über Kinderkrankheiten" (Wien, 1890), p. 211.

vulsions, which disappeared in twenty-four hours. Thomas took the temperature twice daily just preceding the attack without detecting, excepting in a few instances, any appreciable rise of temperature. He concludes, therefore, that a precursory stage manifested by an increase of temperature does not, in most cases, exist, and in the few rare cases in which it is found it is quite insignificant and only of a few hours' duration. Sometimes, he continues, the rise of temperature is coincident with the beginning of the eruption.

In more recent observations the same author[243] found in five cases, taken per rectum every two hours, a slight rise of temperature, 100.9° F. (38.2° C.), preceding the eruption. In a second series the following was recorded:—

In	2	cases	the	highest	temperature	was 100.9° F. (38.5° C.).
"	11	"	"	"	"	" 102.2° F. (39.0° C.).
"	15	"	"	"	"	" 103.1° F. (39.5° C.).
"	10	"	"	"	"	" 104.0° F. (40.0° C.).
"	6	"	"	"	"	" 104.9° F. (40.5° C.).
"	1	case	"	"	"	" 105.8° F. (41.0° C.).

According to Gerhardt,[244] the disease begins with a slight chill, which is sometimes followed by a rapid rise of temperature. This is accompanied at times by pain in the back and extremities, which sometimes continues three days or longer, although most frequently from one-half to one day. Bohn[245] gives the following sequence of symptoms as the most usual: In a previously healthy child there is often slight pallor observed for about half a day. At the same time it may be seen that he is listless, easily fatigued, and has lost his usual appetite. During the following night he sleeps restlessly, is feverish, and the next morning it is observed that he has an eruption.

Von Jürgensen[246] believes that, as is usual in the other infectious diseases, a slight rise of temperature in varicella is to be expected, and that the amount of fever will naturally correspond to the severity of the disease. As illustrating the wide divergence of symptoms which the varicella poison may produce in different individuals, he cites Tham's[247] report of a child, three and a half years old, having severe nervous symptoms, with difficulty of breathing, convulsions, slow pulse, shivering, and a subnormal temperature. Fourteen days

[243] Thomas: Archiv f. Derm. u. Syph., B. 1, S. 335.

[244] Gerhardt (C.): "Lehrbuch der Kinderheilkunden" (Tübingen, 1877).

[245] Bohn: "Varicella," in Gerhardt's "Handbuch," etc. (*loc. cit.*), S. 328.

[246] Von Jürgensen (Theodor): "Acute Exantheme, Scharlach, Rötheln, Varicellen," in Nothnagel's "Specielle Path. und Therap." (Wien, 1896), B. 4, p. 294.

[247] Tham: "Jahrbuch für Kinderheilkunde, Neue Folge," B. 25, S. 155-56.

later a sister of the patient came down with a mild form of varicella, which ran its usual course. Thus, there seems to be a uniformity of opinion as to the uncertain value or total absence of anything to indicate the presence of varicella in the system until the advent of the exanthem. This offers a striking contrast to that presented in even the mildest cases of variola. At the same time it must be conceded that in varicella, as in other diseases, there are many exceptions, some of which may be directly due to the effect of the varicella poison on very impressionable children; others must be ascribed to extraneous diseases having no relationship with varicella excepting their coincidence in the same individual. In addition to the febrile symptoms previously given, those of a more severe character are occasionally encountered, such as delirium (MacCombie) and convulsions (Henoch, Jennings). According to the author first named, in hæmorrhagic cases the rise of temperature may precede the eruption two or three days, during which time there may be repeated hæmatemesis, bloody stools, followed by subnormal temperature and collapse. A supposed case of this kind which terminated fatally occurred in Cleveland during the past winter, in which all of the inmates of the house, not vaccinated, in due time came down with variola. It would be safer, therefore, with Henoch (*loc. cit.*, p. 711), to look upon all severe symptoms during the invasion stage as accidental, and not essentially associated with varicella.

THE ERUPTIVE STAGE, OR PERIOD OF ERUPTION.—This, practically, in the majority of cases, marks the onset of the disease. The mother or nurse usually first discovers an eruption when dressing or bathing the child. It is usually first seen on the upper part of the back, where it attains its most characteristic development. Next it appears on other parts of the trunk, scalp, face, upper and lower extremities, although usually to a less extent. Very often several regions are attacked simultaneously, as the upper part of the trunk and scalp, it never following the order of development observed in variola. It may appear also on the palms of the hands and soles of the feet, although but one or two, sometimes more, lesions are usually found. In several instances photographs of this palmar and plantar eruption have been procured by the writer.

The individual lesions first appear as erythematous spots, which disappear on pressure or by stretching the skin, and, as Trousseau (*loc. cit.*, p. 134) very aptly says, are similar to those observed on the abdomen in enteric fever. They are rose red in color, and spread out at the

periphery, usually following the grain or cleavage lines of the skin, thus often becoming oblong or oval in shape, although, as the erythematous macules gradually blend with the surrounding integument, this may not at first sight be apparent (Plate XXV). At this time they are larger than observed in variola, and resemble somewhat those produced by the sting of insects. They range from one-quarter to one-half inch (0.5 to 1.2 centimetres) in diameter, and in number vary from about half a dozen to twenty or more. According to Trousseau (*loc. cit.*, p. 134), the eruption appears in the form of small rosy spots, slightly acuminated, and in number vary from ten to fifteen the first day, appearing on any part of the body, while Bryce[248] and Gregory (*loc. cit.*) describe an eruption of vesicles as the first thing seen.

Von Jürgensen observed the eruption first on the scalp, then on the face, neck, and upper part of the trunk, following the same order of invasion common in the other diseases of this class. According to Whittaker,[249] it first appears on the neck and chest; Liveing first noticed it on the back and chest; and MacCombie says it first appears almost invariably on the back, chest, and abdomen, but occasionally first on the face or the extremities, with which the writer's experience wholly agrees. Local irritation may not only determine the first appearance of the eruption, but renders it more copious, as is often seen on parts irritated by the clothing, or from bands, garters, and more especially on the buttocks from diapers. In this respect it resembles variola, while it differs in that the exposed surfaces are usually the least involved.

The evolution of the spot is rapid. Within from one to three hours after its appearance a pin-head-sized acumination or slight thickening may be perceptible above the general niveau of the skin, which soon becomes transparent, and a vesicle is formed. This increases in size until the dimensions of a lentil or a split pea are attained. They usually stand out in bold relief (Plate XXVI); are tense, with a broad areola; and are easily ruptured. After rupturing or being pricked with a pin, a serous, translucent fluid escapes and the wall collapses to the general level of the surrounding integument, or the lesion may not completely empty itself, and remains slightly elevated. Much stress is laid on the evacuation of the varicella lesion for diagnostic purposes. While the vesicle is not always unicellular, there are fewer trabeculæ than in the variola

[248] Bryce: Edinburgh Med. and Surg. Jour., vol. xiv, p. 467.

[249] Whittaker (James T.): "Varicella," in Pepper's "Amer. Text-book of Theory and Pract. of Med." (Philadelphia, 1893), vol. i, p. 299.

PLATE XXV.

PLATE XXV.

Varicella, showing Typical Distribution, with Areola well Marked.

PLATE XXVI.

PLATE XXVI.

Varicella, showing Contour of the Lesions, with Areola.

pustule, as may be readily verified by means of a needle. This has been demonstrated many times before medical classes in differentiating between varicella and variola. The individual lesion matures in from six to twenty-four hours, when involution begins. Not all the erythematous blotches develop into vesicles; many fade away before the following day, leaving no trace behind. Others give rise to vesicles without the intermediate formation of a papule or any perceptible elevation in the integument. More rarely vesicles spring up from apparently normal skin. All of these forms may sometimes be seen at one time. Bohn (*loc. cit.*, p. 329) says the vesicle never develops from a papular base; Thomas (*loc. cit.*, p. 11) holds that the characteristic varicella vesicle first appears in the centre of the initial hyperæmia. In this respect it differs widely from that observed in variola. On the palms and soles the vesicular covering is thicker, and the lesion appears more deep-seated, and usually disappears by resorption rather than from rupture of the vesicle wall.

The first outbreak may complete the eruptive stage; more commonly on the following day, or within a few hours, new lesions appear, in character similar to those previously observed, excepting that in the second and third crops they are often more plentiful and of a larger size. Several crops or groups of new lesions may appear for several days, until in number they vary from a half-dozen to two hundred or more. They are always discrete, although when two lesions occur close together they may blend, forming a single, elongated, bean-shaped vesicle. In the meantime the lesions first formed take on an opaque or slightly yellowish color, although the contents never, unless the wall has been ruptured, become thick and creamy as in variola. Many of the lesions, however, do become denuded from scratching or rubbing of the clothing, when true pustules, covered by a brownish crust, may be seen. Resorption takes place in others, leaving a slightly elevated papule surmounted by an easily detached crust. Commonly new lesions appear without order either as to time or distribution, although the extremities are usually last affected. In this the eruption is essentially polymorphous; that is, macules or erythematous spots intermingle with vesicles in different stages of development, together with light-colored pustules, crusts, and small excoriated areas or papules. It is well to bear in mind that essentially the typical varicella lesion is non-indurated and when ruptured collapses, especially in the centre, and tends to conform to the general level of the skin. Inflammatory disturbances induced by the introduction of pus organisms and other

pathogenic substances frequently complicate the simple process observed in varicella and render the disease more or less protracted.

The mucous membranes are likewise affected in varicella, but never, so far as I am aware, until the exanthem appears. In fact, in cases observed with special reference to this point, the enanthem seemed to be coincident with the exanthem. At other times it appeared only at the height of the cutaneous eruption, and in some instances no disturbance whatsoever could be detected. When present, the lesions are most commonly seen on the soft palate, less frequently on the hard palate, inner surface of the cheeks and tongue, and on other parts of the mouth and throat. Not infrequently they appear on the vaginal mucous membrane, and sometimes on the prepuce of boys. Both Thomas and Henoch have reported vesicles on the conjunctiva. In these positions the lesions conform somewhat in character to those observed on the skin, namely: the formation of transparent, thin-walled vesicles, surrounded by an erythematous halo. In the mouth the epithelial covering soon becomes denuded, leaving reddish, excoriated spots, which may readily be mistaken for aphthous stomatitis. They are usually few in number and quickly disappear.

The subjective symptoms during the eruptive period are always slight, and may be entirely absent. When prodromal symptoms are present they may also disappear with the appearance of the rash. With each crop of vesicles there is usually a slight rise of temperature. Sometimes this subsides between the cutaneous outbreaks, sometimes it is continuous, with morning remissions, during the whole eruptive period. The temperature scarcely ever rises more than 2 or 3 degrees. The slight febrile disturbance does not, however, interfere perceptibly with the cheerfulness of the child nor his relish for food, and in many cases children play about much as they are accustomed to do in health. Such cases frequently present themselves at public clinics, and I know of no instance in which harm has resulted from this exposure even during the winter months. Sometimes, toward evening, the child becomes peevish, and during the night sleep may be more or less restless; otherwise no general symptoms are, as a rule, present.

In other cases, and in the majority of strumous and asylum children, according to my observation, the eruption is accompanied by definite symptoms, more especially referable to the influence of the varicella poison on the nerve-centres, in which case the child is dull or sleepy during the day, is sometimes chilly, has marked loss of appetite with thirst, is sometimes constipated, and is excitable or wakeful

PLATE XXVII.

XXVII

VARICELLA—resembling variola.
(Through the courtesy of Dr. H. H. Powell)

PLATE XXVIII.

XXVIII

VARICELLA—showing posterior view of one in the preceding.

PLATE XXIX.

PLATE XXIX.

Varicella resembling Varioloid.

at night. More rarely, according to Jennings,[250] the throat is slightly sore and the lymphatic glands are swollen and tender. This the present writer has never seen.

From the foregoing it will appear that the *stage of desquamation* begins a few hours after the appearance of the eruptions, and goes on *pari passu* with the development of the lesions. As soon as resolution begins, itching may be troublesome, and in this way the vesicles become denuded from scratching.

COMPLICATIONS AND SEQUELÆ.

Varicella is remarkably free from complications, and ill effects from the disease in an otherwise healthy child may never occur in the practice of many physicians of wide experience. In very delicate subjects, however, a period of ill health is sometimes observed to follow varicella, as from any other slight constitutional disturbance. The most frequent concomitants, so far as the writer has observed, arise from the numerous foci exposed to local infection. It is a matter of surprise that more cases of secondary infection do not occur, when we consider the number of denuded areas through which bacteria and cocci may readily gain entrance. From this cause severe inflammation of the vesicles sometimes occurs, or they extend at the periphery much as is seen in impetigo and similar affections, and probably from the same cause, namely: the development of various microorganisms. The cases of impetigo reported by Descroizilles,[251] the stafilococcia varicellosa of Bolognini,[252] the varicella-prurigo of Hutchinson,[253] and those of bullous varicella by Pye-Smith[254] may be cited as belonging to this class. In more destructive processes deep ulcers or gangrene may ensue. Such a case came under the writer's observation during the past year in consultation with a colleague, in which some of the lesions, instead of healing, became angry, dark colored, and finally necrotic. Only eight or ten lesions were thus affected, some of them but slightly. They were all situated on the lower part of the trunk and thighs. In the course of three or four weeks healthy granulations appeared, and finally the patient recovered, with depressed

[250] Jennings: "Varicella," in Keating's "Cyclopædia of the Diseases of Children" (Philadelphia, 1889), vol. i, p. 762.

[251] Descroizilles (A.): France méd. (Paris, 1898), xlv, 657.

[252] Bolognini (P.): Pediatria (Napoli, 1897), vol. 76-80.

[253] Hutchinson (Jonathan): "Clinical Lectures" (London, 1879), vol. i, pp. 15 *et seq.*

[254] Pye-Smith: Brit. Jour. of Derm., 1897, vol. ix, p. 148.

cicatrices marking the gangrenous areas. Cultures made from the necrosed material showed a mixed infection, in which the streptococcus pyogenes was found. The cases of varicella gangrenosa reported by Hutchinson,[255] Howard,[256] Crocker,[257] Vierordt,[258] Lockwood,[259] and Silver[260] seem to belong to the same category. The writer would therefore place the formation of bullæ, undue inflammation, ulceration, and gangrene as instances of mixed secondary infection rather than as special varieties of varicella.

Varicella Hæmorrhagica.—Hæmorrhagic varicella has been occasionally seen. Ploc[261] and Andrew[262] have observed it as a complication in cachectic cases. According to MacCombie, large and small ecchymoses appear, with hæmorrhage into the cutis under the vesicle, accompanied by hæmatemesis and melæna; and, while the symptoms are severe, recovery usually takes place. It is an extremely infrequent complication, and occurs in certain cachectic or debilitated subjects, and more especially in the so-called "bleeders"—persons having hæmolysis or hæmophilia.

Acute nephritis sometimes arises during the course of varicella, and, as in scarlatina, may be a serious complication. Such cases have been reported by Henoch,[263] Rille,[264] Janssen,[265] Openheim,[266] von Jürgensen (*op. cit.*, p. 300), Högyes,[267] Silver (*loc. cit.*), Rasch,[268] Unger, and others. In most of these cases the nephritis appeared after the decline of the eruption, and in one instance (Rille) as late as seventeen days after the last crop of vesicles. In this case, which terminated fatally, a post-mortem examination revealed parenchymatous nephritis. The clinical history, however, is usually that of mild tubular nephritis. While death has seldom occurred from this complication, the danger of the kidneys becoming structually impaired is apparent,

[255] Hutchinson (J.), quoted by J. Lewis Smith: "Med. and Surg. Dis. of Infancy and Childhood" (Philadelphia, 1896), p. 327.

[256] Howard: In Eustace Smith's "Diseases of Children" (New York, 1884); see also Brit. Med. Jour., 1833, i, 905.

[257] Crocker (H. Radcliffe): London Lancet, May 30, 1885.

[258] Vierordt: In Pentzoldt-Stinzing's "Handbuch der speciellen Therapie innerer Krankheiten," B. 1, S. 187 (see von Jürgensen).

[259] Lockwood (W. F.): Arch. Pediat. (New York, 1897), xiv, 680-683.

[260] Silver (L. M.): *Ibid.*

[261] Ploc (K.): Casop. lék. cesk. (V. Praze, 1898), xxxvii, 84-86.

[262] Andrew: "Clinical Society's Transactions" (London, 1890), xxiii, p. 79.

[263] Henoch: Berliner klin. Woch., No. 2, January 14, 1884.

[264] Rille: *Ibid.*; also in Wiener klin. Woch., 1889, and in Deutsche med. Woch., 1891.

[265] Janssen: Nedrl. Tijdschr., 1884, B. 20, S. 223.

[266] Openheim: Berliner klin. Woch., December 26, 1887.

[267] Högyes: "Jahrbuch für Kinderh., N. F.," B. 23, S. 337.

[268] Rasch: Tijdskr. for praktisk med., 1884, S. 68.

and the necessity of examining the urine in all cases of varicella cannot, therefore, be too strongly urged.

Pneumonia has been reported by Rille and Powell,[269] pleurisy and synovitis by Semtschenko,[270] Loudon, Perret, and others; simple generalized œdema by Starck,[271] scleroderma *en plaques* by Bouvy,[272] scrofulo-tuberculosis of the skin by Foulard,[273] and acute tuberculosis of the lungs by Eustace Smith.[274] For a further account of the complications of varicella, together with a carefully prepared bibliography, the reader is referred to Netter's article in the *Archiv für Kinderheilkunde*, xxx, 1900.

PATHOLOGY.

The superficial position of the lesion of the skin in varicella, which is covered by the thinest layer of epithelium, is constant. This characteristic feature led to its early recognition as a distinct disease, and the term crystalli, applied to it by Guido Guidi ("Vidus Vidius") and Ingrassias, clearly indicates that they were familiar with its development.

The changes which take place in the formation of the vesicle are essentially as follow: There is, first, a slight dilatation of the superficial capillaries in the papillary layer of the derma, which is soon followed by an exudation of serum. This is never so abundant as in variola, but gives rise to the mild grade of œdema that may be detected in the erythematous macules.

The rapid development of the vesicle beneath the superficial layers of the epidermis leads to the degeneration and liquefaction of the epithelial cells, and the destruction of the delicate septa, while as it develops, there is seen, not uncommonly, a bright-red zone just about the outer margin, due to the dilatation of the superficial vessels. The contents of the vesicle, first clear, become cloudy and opaque after the second or third day, owing to the addition of cellular elements; they rarely become purulent.

Unlike the lesion in variola, there are commonly no cellular septa present, though in certain instances they may be found.

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[269] Powell (H. H.): "Internat. Clinics" (Philadelphia, January, 1897), vol. iv, p. 49.
[270] Semtschenko, "Jahrbuch für Kinderh., N. F.," B. 25, S. 171.
[271] Von Starck: Deutsches Arch. f. klin. Med. (Leipzig, 1896), lvii, 448.
[272] Bouvy (L.): Jour. de clin. et de thérap. inf. (1898), vi, 486-489.
[273] Foulard (M. H.): Ann. de derm. et de la syph. (1896), vii, p. 362.
[274] Smith (Eustace): "Disease in Children" (New York, 1884), p. 49.

The changes which take place are confined wholly to the epidermis. The vesicles contain granular fibrin, a moderate cellular exudate, cellular *débris*, and serum; this differs markedly from the exudate in variola, which is usually very rich in cells, especially plasma-cells. The pock in varicella is shallow, rarely involving the papillæ of the cutis, and as its contents are absorbed the superficial covering is cast off in the form of a brownish scab, sometimes with marked pigmentation, but no resulting scar. The occurrence of a scar following the varicella lesion is occasionally seen.

ETIOLOGY.

The predisposing causes of varicella are as little understood as are those of other diseases of this important group. Unlike them it is seen throughout the whole year, and is less epidemic in character. In large cities there are usually sporadic cases at all times, while epidemics occur at frequent, though irregular, intervals. They are more noticeable during the spring and fall, and especially at the opening of schools and kindergartens. Insanitary surroundings act as predisposing factors, and frequently determine both the severity of the disease and the complications which arise. It was formerly thought that varicella could not be inoculated. Thus, Heberden in 150 cases, as well as Vetter[275] and Fleischmann,[276] obtained negative results. Thomas's experiments were likewise unsuccessful, as were those of Heim.[277] Hesse failed in 87 inoculations, while in 17 he produced some local disturbance at the seat of inoculation, and in 9 the inoculation was followed by a general eruption (Thomas). In this country J. Lewis Smith[278] inoculated the contents of varicella vesicles in children who had never had the disease, with negative results. The present writer has inoculated the clear serum taken from varicella vesicles without ever being able to produce the disease. On the other hand, Steiner[279] inoculated 10 children, in 8 of whom the disease appeared in a typical form. This, so far as I am aware, is the only instance of successful inoculation. It is extremely doubtful, therefore, whether varicella is contagious in the sense that variola and syphilis are.

[275] Vetter, Archiv der Heilkunde (1860), B. 1, S. 286; and in Virchow's Archiv (1864), B. 31, S. 400.

[276] Fleischmann (L.): Archiv für Derm. und Syph. (1871), B. 3, S. 498.

[277] Heim: *Loc. cit.*

[278] Smith (J. Lewis): "Med. and Surg. Diseases of Infancy and Childhood" (Philadelphia, 1896), p. 326.

[279] Steiner: Wiener med. Woch., 1875.

Its infectious nature has long since been known, and Heberden regarded varicella as being as infectious as variola. Its infectious property, however, is short lived, and does not cling to clothing; nor does it remain about apartments so long as that of variola, scarlatina, or even rubeola. The contagium, like others of this class, probably gains access through the air-passages; in fact, from our present knowledge this seems to be the only avenue patent to its invasion. Direct exposure from person to person is, therefore, usually necessary, and undoubtedly this is the common mode of spreading the disease. Unlike variola and other affections of this group, age plays an important etiological rôle. It is essentially a child's disease, whereas, with the possible exception of scarlet fever and rubella after middle life, it has been shown that the exanthemata are communicated with equal facility from early childhood to old age. During a period of twenty years in which the present writer has been occupied in studying eruptive disorders, not a single instance has occurred in which varicella appeared after the fifteenth year. While unwilling to believe that varicella never occurs after puberty, yet this experience does not seem to be in any way unique. Hutchinson (*loc. cit.*, p. 229), with the abundant clinical material in eruptive diseases which London affords, has, he thinks, seen it once or twice about the age of twenty, and remarks that a "point of great interest in varicella is *the almost absolute immunity of adults.*" Thomas (*loc. cit.*, p. 8) says: "Varicella is a disease of childhood, and attacks by preference young children, and even sucklings. In children over ten years of age attacks are infrequent, and I never saw an adult suffering from varicella." According to Graham,[280] it is seldom seen after ten years of age, and Eustace Smith (*loc. cit.*, p. 48) begins his article with the statement that "Chicken-pox is seldom seen except in young subjects, and attacks by preference children aged from two to six years." This is in accord with Bohn, who has, in one instance only, encountered it in the sixteenth year. Von Jürgensen says it is a disease which probably pertains entirely to childhood, and rarely attacks any above ten years of age. Kinsman,[281] in an experience with numerous epidemics covering a period of over thirty years, is positive that he has never seen a case of chicken-pox in an adult. On the other hand, Gregory has met with 7 instances of varicella in adult females,

[280] Graham (J. E.): "Varicella," in Morrow's "System of Dermatology," etc. (New York, 1894), vol. iii, p. 98.

[281] Kinsman (D. N.): "Discussion on the Diagnosis of Small-pox." "Transactions of the Ohio State Medical Society," 1899, p. 108.

MacCombie has seen it in 7 persons over thirty years of age. J. Lewis Smith (*loc. cit.*, p. 326), than whom few men have had a larger experience, says: "I have seen one adult case, which I recall to mind, and Professor Flint states that he has also observed varicella in the adult; but its occurrence at this time of life is rare." Finally, Osler says it is rarely seen in adults.

It seems, therefore, established that varicella finds only in childhood a suitable soil for development; that, with puberty, immunity is acquired, and, while there are exceptions to this rule, they are so infrequent as to be regarded as anomalous, and in no way invalidating the most constant, as well as the most characteristic, feature of the disease.

Varicella, then, may be encountered from one or two months after birth to puberty, and in asylums and similar institutions most cases occur between the ages of two and six years, while in private families children often escape until a later period, which varies from three to twelve years.

It is also pretty well established that second attacks may occur, and Gerhardt[282] has seen three attacks of varicella in the same child. Second attacks are extremely infrequent, however, and in this respect the disease probably does not differ from variola, rubeola, and other affections which are self-protective.

DIAGNOSIS.

The distinguishing features of varicella are: (*a*) Its mild prodromal symptoms, which may be wholly absent. (*b*) The appearance of the eruption on the trunk, where it is usually more abundant than on the face or hands. (*c*) The multiform character of the eruption, its superficial position, comparable to drops of water sprinkled over the skin, and its appearance on the same region in successive crops. (*d*) Its mild constitutional symptoms and short duration, the disease usually terminating within from five to fourteen days. (*e*) Varicella is mildly infectious and always gives rise to a like disease.

With the exception of the last mentioned, these cardinal features have been duly considered, and at this late day it is not thought necessary to enter into a discussion as to the grounds for describing it as a separate affection and in no sense related to variola. Those who desire a full discussion of this subject may find it in many of the works to which reference has already been made.

[282] Gerhardt (*loc. cit.*).

The points of differential diagnosis between varicella and variola, the disease to which it bears the strongest resemblance, will be found under the latter disease. The disease next to variola with which varicella is sometimes confounded may be mentioned:—

Impetigo.—When the case is seen late in its course, or after the rupture of some of the vesicles; the diagnosis between chicken-pox and impetigo may not easily be made. What was said under variola in this connection applies equally to varicella. It should be remembered that impetigo usually appears on the face, especially about the mouth and nose; next in frequency on the hands; and is clearly the result of inoculation from one region to another. This is quite unlike the development of the varicella exanthem. Again, in impetigo the lesions extend at the periphery in the form of a bullous ring, and seldom present the prominent, tense, bead-like, transparent vesicles of chicken-pox. The course of the two diseases is quite dissimilar; impetigo is progressive and of much longer duration, often lasting weeks or even months, while chicken-pox remains but a few days.

Finally, impetigo is contagious and never infectious, while chicken-pox can, with difficulty, be successfully inoculated. Impetigo is common after puberty, while chicken-pox seldom occurs later than from ten to fourteen years of age.

PROGNOSIS.

It has been observed that the course of varicella is largely influenced by the presence or absence of healthful surroundings, and that the previous condition of health influences in a high degree the appearance of complications and sequelæ. It therefore follows that with ordinary care, in well appointed dwellings, and without any strong predisposition to disease, the prognosis in varicella is invariably favorable. Trousseau (*loc. cit.*, p. 136) expresses it in unmistakable terms when he says: "No physician has ever seen a patient die of chicken-pox, though, of course, there may be a fatal issue from some complications independent of the exanthematous fever." In asylums and the wards of hospitals, delicate, strumous children occasionally develop serious complications, or an anæmic condition may follow an attack of varicella. This has been ably set forth by Walsh,[283] who found tuberculosis, anæmia, etc., induced by an attack of chicken-pox in an orthopædic

[283] Walsh (J. J.): Ther. Gaz. (Detroit, 1896), 3, s., xii, 657-660.

ward. These must be regarded as rare exceptions, and of all infectious diseases of childhood varicella is the least fatal.

TREATMENT.

In general, prophylactic treatment is uncalled for in varicella. It is not expedient, however, needlessly to expose children to the disease, and especially those who are delicate or enfeebled from any cause, or those in whom struma, rachitis, or a strong predisposition to tuberculosis exists.

After recovery the rooms should be aired, and, when thought desirable, may be fumigated, before other children are allowed to enter. The disease itself calls for no special treatment, although it is advisable to keep the patient within doors and in bed during any marked febrile disturbance. Light diet and a well ventilated room are to be recommended in all cases. Sometimes mild antifebrile measures are indicated, and such other treatment may be given as the occasion demands. When an anæmic state follows, change of air or removal into the country is advisable, together with nourishing and easily digestible food. Sometimes vegetable bitters, iron, and codliver-oil are useful. The local treatment is usually of more importance. Cleanliness should be scrupulously maintained. The underclothing should be changed at frequent intervals and the body bathed; the finger-nails should be cut short; and a nail brush, with one of the antiseptic solutions mentioned at the end of the volume, used daily. If pus forms or the vesicles rapidly enlarge, they should be opened and the sacks flushed out with a solution of boric acid or some other disinfectant (Nos. 2 or 3 in "Addendum"). In case gangrene occurs, a stimulating regimen and strict local asepsis is imperative. For this purpose it is necessary to remove all *débris* by means of a curette, and the cavity should be packed or otherwise dressed with a solution of corrosive sublimate (1 to 1000). On the face, when the vesicles become yellow, they should be opened and some bland antiseptic dressing applied (No. 5 in "Addendum").

CHAPTER V.

SCARLATINA.

(Scarlet fever; German, *scharlach*; French, *scarlatine*; Italian, *scarlattina*; Spanish, *escarlatina*; Danish and Norwegian, *skarlagensfeber*; Dutch, *scharlakenkoorts*; Latin, *febris rubra*.)

ALTHOUGH scarlet fever had been studied and described by many of the earlier observers, and by some of them most accurately portrayed (see pages 22 to 27), it was not until the appearance of Sydenham's work late in the seventeenth century (1670-74) that it was first assigned a place as a distinct disease among the acute exanthemata. Not until late in the eighteenth century was it sharply differentiated from measles by Withering, in 1793 (*loc. cit.*), prior to his time great confusion having existed between the three diseases: measles, scarlatina, and diphtheria. Even so late as 1875 Gerhardt[284] raised the question as to whether what we call scarlatina was not rather a symptom-complex, than a disease *sui generis*. Since the end of the seventeenth century scarlet fever has been present, more or less constantly, throughout the northwestern countries of Europe, while Asia and Africa have, with certain local exceptions, remained quite as constantly free from it. Egypt, India, Burmah, Ceylon, and Japan are protected in some way against outbreaks of scarlatina in an epidemic form, isolated and small groups of cases occurring from time to time, due to importation.

In North America the disease first appeared in Massachusetts in 1735, and from this point spread slowly, invading the New England States along the sea-coast, and appearing in New York State in 1746. Throughout the last half of the eighteenth century scattered outbreaks of scarlatina occurred along the sea-board, but these were infrequent, and it was not until 1791 that it extended inland, reaching Canada early in the nineteenth century. From this time scarlet fever has been almost constantly present in epidemic form throughout the larger cities of North America. South America remained apparently free from the disease until 1830, since which time it has become scattered over the continent, and frequently appears in epidemics of varying malignancy. In Australia the presence of scarlatina in epidemic form is uncommon.

[284] Gerhardt (C.): "Jahrbuch für Kinderh., N. F.," vol. ix, p. 322.

DEFINITION.

Scarlet fever is an acute, specific, contagious, and infectious febrile disease, characterized by its sudden onset, which is commonly ushered in by headache, sore throat, and vomiting, together with a very rapid pulse, a sharp rise of temperature, and by the appearance of an erythematous rash, seen usually by the second day upon the upper thorax and neck, which then spreads rapidly over the greater part, or the entire surface, of the body, and is followed after its disappearance, by desquamation. It is almost constantly associated with a more or less intense inflammation of the pharynx and with enlargement of the neighboring lymphatic glands, and is further marked by a grave tendency to certain complications. One attack usually confers immunity.

Among the contagious and eruptive fevers none presents so many varied types as scarlet fever, ranging, as it does, from the mildest form, SCARLATINA SIMPLEX, or BENIGNA, to the most malignant type, SCARLATINA MALIGNA, called by the French *foudroyante*. Between these two extremes we find an almost endless variation from the normal, one shading gradually into the other; so that any sharp differentiation into groups is quite impossible. Clinically, however, we may distinguish three types: the moderate, or mild; the severe; and the malignant, or cerebral, form. The following is, perhaps, an even better classification: (*a*) SIMPLE, (*b*) SEPTIC, and (*c*) TOXIC, to which might well be added a fourth group, including the anomalous cases, though these may be placed under one of the three main divisions, as variations, only, from a given type.

SYMPTOMATOLOGY.

As in small-pox and measles, we have here to differentiate the several stages of the disease, which may be classified as the stages of incubation (*stadium incubationis*), of invasion (*stadium prodromorum*), of eruption (*stadium eruptionis*), and of desquamation (*stadium desquamationis*).

STAGE OF INCUBATION.—Much difference of opinion has existed as to the duration of the period of incubation in scarlet fever, it being necessarily difficult to determine with exactness the length of time that has elapsed between exposure to the disease and the appearance of the symptoms. This stage lasts from a few days to a week, with, of course, exceptions in which the period of incubation may be short-

ened to a few hours or may exceed the above limit by several days. Eichhorst[285] and von Leube[286] give it as from four to seven days.

The epidemic which broke out in the Canary Islands in 1873-75 afforded many excellent opportunities for a careful study of the period intervening between exposure and the appearance of the symptoms. For fifty-seven years prior to this time not a single case of scarlet fever had been known to exist in these islands. This epidemic, though it could not be definitely proved, originated probably in the Shetland or the Orkney Islands. Hoff[287] found, from his observations at the time, that in this epidemic the average duration of the period of incubation was from eight to nine days, with, however, certain exceptions. Petersen,[288] during the same outbreak, noted, in those cases in which he could accurately determine it, an incubation of from nine to eleven days, which Lund[289] was able to confirm. In nine cases quoted by him it was as follows:—

Of	9	days'	duration,	1 case.
"	10	"	"	5 cases.
"	11	"	"	3 "

Murchison,[290] in 1864, published a series of thirteen cases, in none of which did the period of incubation go beyond six days, as follows:—

Of	less	than	24	hours'	duration,	2 cases.
"	"	"	31½	"	"	1 case.
"	"	"	36	"	"	1 "
"	"	"	40	"	"	1 "
"	"	"	3	days'	"	2 cases.
"	"	"	3½	"	"	1 case.
"	"	"	4	"	"	1 "
"	"	"	5	"	"	3 cases.
"	"	"	6	"	"	1 case.

Later, in 1878, the same observer[291] published a series of seventy-five cases, in not one of which the period of incubation exceeded that noted above.

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[285] Eichhorst: "Specielle Pathologie und Therapie" (Leipzig, 1897), vol. iv, p. 231.

[286] Von Leube: "Specielle Diagnose der Inneren Krankheiten" (Leipzig, 1898), p. 413.

[287] Hoff: "Sundhedskollegiets Aarsberetning," 1876. Quoted by von Jürgensen, "Acute Exantheme, Scharlach, Rotheln, Varicellen" (Wien, 1896), p. 7.

[288] *Ibid.*, p. 8.

[289] *Ibid.*

[290] Murchison (C.): "Contributions to the Etiology, Pathology, and Treatment of Scarlet Fever." The London Lancet, 1864, vol. ii, pp. 481-485.

[291] Murchison (C.): "Observations on the Period of Incubation of Scarlet Fever." "Clinical Society's Transactions" (London, 1878), vol. xi, pp. 238-265.

In striking contrast with this careful series is the following equally valuable observation by E. Hagenbach-Burkhardt,[292] who, in a series of 58 cases in which he was able to ascertain the duration of the period of incubation, found that in 38 it exceeded six days, as follows:—

Of	less	than	7	days'	duration,	3	cases.
"	"	"	8	"	"	4	"
"	"	"	9	"	"	2	"
"	"	"	10	"	"	1	case.
"	"	"	11	"	"	5	cases.
"	"	"	12	"	"	1	case.
"	"	"	13	"	"	4	cases.
"	"	"	14	"	"	2	"
"	"	"	15	"	"	5	"
"	"	"	17	"	"	2	"
"	"	"	18	"	"	1	case.
"	"	"	19	"	"	2	cases.
Of	over		20	"	"	6	"

Hagenbach gives these cases with some reserve, assuming them to be as nearly accurate as such observations can be, and admits that during what appears to be a long period of incubation one may be deceived by a subsequent indirect infection. But it is surely impossible that in such a series as quoted above indirect infection could play any important part. It is clearly shown from these instances that, in exceptional cases, the duration of incubation may be prolonged considerably beyond the average time.

Conditions which Modify the Stage of Incubation. — It has long been recognized that certain conditions strikingly modify the length of the period of incubation, increasing at the same time the individual's susceptibility to the disease. The existence of a wound in the person exposed seems to offer a ready entrance to the poison, and in the majority of such cases the period of incubation is much shortened, as in scarlet fever following tracheotomy wounds in children (Hagenbach, *loc. cit.*, p. 115) or in cases of ordinary surgical and accidental wounds. A notable exception to this latter statement is the case of von Leube's (*loc. cit.*, p. 413), who, while making a post-mortem examination upon a body dead of scarlet fever, injured himself slightly in the index finger, and eleven days afterward developed a

[292] Hagenbach-Burkhardt (F.): "Ueber Spitalinfectionen." "Jahrb. f. Kinderh., N. F.," vol. xxiv, pp. 105 *et seq.*

typical attack of scarlatina. Johannessen[293] has further attempted to demonstrate that the duration of the stage of incubation is affected by the virulence of the epidemic. The milder the type of the prevailing epidemic, the longer; while, the more malignant, the shorter is the period of incubation.

In many instances, when exposure has occurred during confinement, or the puerperium, in addition to the increased susceptibility, the average duration of incubation has been shown to be shorter than in the normal individual.

As a rule, during the period of incubation subjective symptoms are absent, the first indications of the disease appearing during the stage of invasion.

SCARLATINA SIMPLEX.

ACTUAL ATTACK.

PERIOD OF INVASION, OR PRODROMAL STAGE (*Stadium Prodromorum*).—The period of invasion in scarlatina is usually of very short duration, and represents that period immediately preceding the actual attack. During this time some vague and slight subjective symptoms may be complained of by the individual, lasting commonly twenty-four hours or less, though exceptionally extending over several days (Mayr[294]). Eichhorst (*loc. cit.*, p. 232) gives the duration as from twenty-four to forty-eight hours; Henoch,[295] twenty-four hours, though exceptionally thirty-six to forty-eight hours. By many observers it is held that the intensity of the initial symptoms bears an intimate relation to the severity of the infection. While this may be true in a certain number of cases, it is by no means constant. In Henoch's opinion (*loc. cit.*), no accurate judgment as to the mildness or severity of the attack can in all instances be formed from the early symptoms.

As a rule, the onset is sudden, occurring in an individual apparently well, in whom, previous to the appearance of the first active symptoms, there has been no indication of the threatened infection. This is more often true in the case of children than of adults, though not infrequently at either age slight anorexia, listlessness, or irritability

[293] Johannessen (Axel): "Die Epidemische Verbreitung des Scharlachfiebers in Norwegen" (Christiania, 1884), p. 166.

[294] Mayr: "Scarlatina," in Hebra's "Diseases of the Skin." "Sydenham Society's Trans." (London, 1866), vol. i, p. 190.

[295] Henoch (Ed.): "Vorlesungen ueber Kinderkrankh." (Berlin, 1897), p. 643.

may precede the earliest signs of the disease. Children may at times complain of a tickling sensation in the throat and vague pains throughout the back and limbs. In adults the early headache is more pronounced; the subjective symptoms in the throat may amount to actual soreness, and there may be great languor and dullness preceding the first active indications of the attack. In the vast majority of cases, however, the disease is ushered in abruptly by headache, sore throat, and a rapid rise of temperature; while in children, in addition to these three cardinal symptoms, the onset is almost constantly associated with vomiting, which may or may not be repeated. Occasionally, chilly sensations, more rarely a true chill, precede the sudden rise of temperature; and, in young children, convulsions very commonly mark the beginning of the disease. At other times a severe diarrhœa is the first symptom; or, again, a sudden attack of syncope, and in rarer instances one or more epileptiform attacks mark the onset.[296] Thomas[297] states that vomiting associated with convulsions occurs more frequently as an initial symptom of scarlatina than of any other disease of childhood, excepting only small-pox and pneumonia.

With the appearance of these early symptoms the temperature suddenly rises, reaching 102° F. (38.8° C.) or over by the evening of the first or early on the second day, if, as so often happens, the attack has developed late in the afternoon or evening. The pulse is full and very rapid (120 to 140 beats to the minute); the younger the child, the more rapid, as a rule, is the pulse-rate. This rapidity of the pulse very frequently persists throughout the course of the attack and usually shows a marked disproportion to the height of the fever: a point upon which Trousseau[298] laid great stress. Within the first few hours the submaxillary lymphatic glands at the angle of the jaw are swollen, and frequently slightly tender on palpation. The tongue is coated with a grayish-white fur of varying thickness, while the edges and tip are reddened, and the papillæ remaining free from this exudate early become prominent: a point of no little diagnostic value. There is increased thirst. The mucous membrane of the mouth is reddened; the pharynx, the tonsils, and the uvula are injected; and prostration is more or less marked, depending upon the severity of the infection. Upon examination of the throat at this stage, the early evidences of

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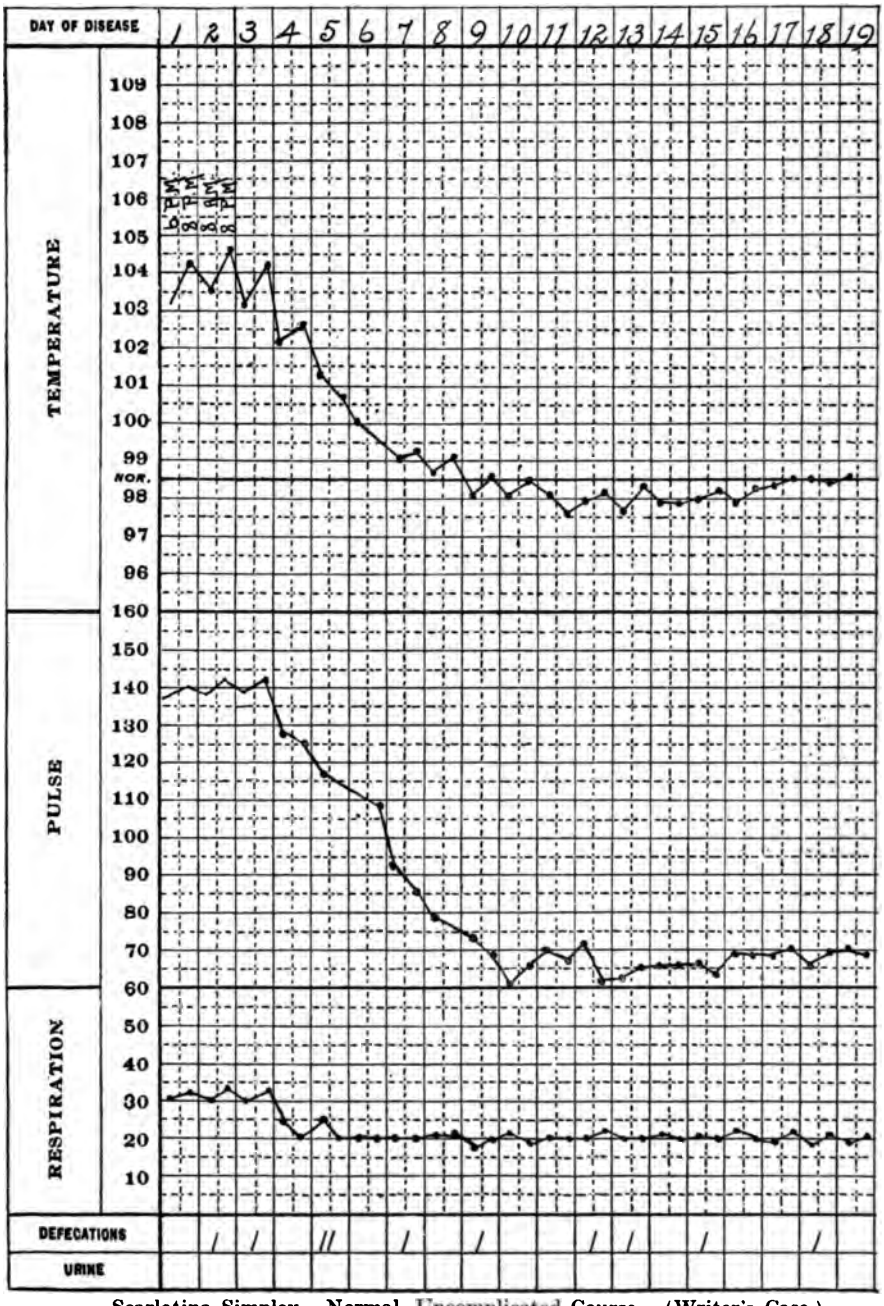
[296] Henoch (*loc. cit.*).

[297] Thomas (Louis): "Scarlatina," in von Ziemssen's "Cyclopædia of the Practice of Medicine" (Transl., New York, 1875), vol. ii, p. 238.

[298] Trousseau's "Clinical Medicine" (Transl., Phila., 1873), p. 141.



Scarlatina Simplex. Normal, Uncomplicated Course. (Writer's Case.)

the eruption are seen on the buccal mucous membrane, though they are absent in those cases of such a mild type that the throat symptoms are almost, if not wholly, wanting. Monti[299] has called especial attention to the early appearance of the enanthem in scarlatina, which is seen late on the first or early on the second day. This appears as a diffuse mottled reddening, which, beginning commonly upon the uvula, spreads quickly over the soft and hard palates, covering the pillars of the fauces, and finally, the mucous membrane of the cheeks, but not, as a rule, extending on to the post-pharyngeal wall. The injection of the tonsils is marked, the follicles on their surfaces are swollen and prominent, and the mouth is dry.

The clinical picture of the disease at this time, late on the first or early on the second day, is that of the early stage of an acute fever. In adults there is great relaxation and lassitude. Children, as a rule, are dull and apathetic, showing a great desire to be left undisturbed. They may be restless and anxious, and, if the fever be high, mild delirium may be present early in the course of the disease. In the severer forms this cerebral disturbance is much more pronounced, and the restlessness and delirium may be extreme. The face is flushed, the eyes are dull and heavy, and the conjunctivæ slightly injected, lacking, however, the active catarrhal inflammation seen in measles. Unless there be some co-existing trouble, the lungs are clear, and physical examination reveals nothing except as described above. The urine is scanty and high colored, and may, if the fever be high, contain a slight trace of albumin from the first.

Stage of Eruption (*Stadium Eruptionis*). — The eruption of scarlet fever presents such constant variations, both as regards character and duration, and is necessarily so modified by the nature of the skin upon which it develops, as well as by the intensity of the infection, that it is impossible to ascribe to it any fixed course in a single given type of the disease. As a rule, it develops more rapidly in blonde children and full-blooded individuals than in the darker skin of brunettes or in the pale and anæmic. The warmth of the bedclothes and crying increase the intensity of the eruption, while a hot bath will frequently heighten the color, often turning a pale red into a bright scarlet. As in all the eruptive fevers, the rash is more pronounced over those areas exposed to pressure or irritation, as the nates and back. Upon pressure the scarlet blush of the eruption momen-

[299] Monti (A.): "Studien ueber das Verhalten der Schleimhaute bei den acuten Exanthemen." "Jahrb. f. Kindh., N. F.," vol. vii, pp. 227 *et seq.*

tarily pales, only to return with the removal of the pressure. This paling of the eruption is not seen, of course, in those cases in which actual hæmorrhage into the skin has occurred, and is not in any way characteristic of scarlet fever.

Rapidly following the appearance of the initial symptoms of the stage of invasion (usually within the first twenty-four hours) the characteristic rash is seen upon the neck and upper thorax in the subclavicular region, and less commonly upon the small of the back, as a diffuse, bright-red (scarlet) blush, which, when examined more closely, is found to be made up of countless, minute, brightly injected spots, pin-point in size, occupying the sites of the hair-follicles, closely studded together, and separated from one another only by small areas of pale skin.

As the eruption progresses these pale areas acquire a brighter erythematous tinge, giving to the diffuse redness a much more characteristic scarlet hue, while there may develop coincidently a slight œdema of the skin. The rash extends rapidly from above downward, spreading in a few hours to the arms, where it is well marked about the elbows; and in the course of twelve to twenty-four hours—rarely longer—reaches the trunk and legs. Upon the face, in contrast to small-pox and measles, the true scarlatinal eruption is much less marked, and is seen, as a rule, only upon the forehead and cheeks, the latter being frequently deeply flushed and injected, while the immediate neighborhood of the nose and mouth remains free from the eruption and presents, in strong contrast, a peculiar, striking pallor.

Upon the dorsal surface of the hands and feet the eruption is often very marked, showing characteristic isolated points of a pronounced scarlet tint, while the palmar and plantar surfaces, though frequently deeply injected, do not usually show the true punctate scarlatinal rash. Over the trunk and extremities the eruption appears commonly in irregular patches of varying size of an intense scarlet color, and upon the latter frequently shows a tendency to occupy the extensor, rather than the flexor, surfaces.

Usually by the evening of the second or the third day the rash has reached its greatest extent and intensity, covering the entire body as a bright scarlet blush, which has been variously described as of the color of a "boiled lobster," "raspberry-juice," etc. With slight daily variations, influenced somewhat by the rise and fall in temperature, the rash remains at its maximum for from one to three days—exceptionally longer. Henoch (*loc. cit.*, p. 645) has called attention to the

remittent intensity of the eruption, which is, as a rule, more pronounced in the evening than during the morning hours, and has noted, further, a change from day to day, which is not always in keeping with the variations in the temperature-curve. With the appearance and extension of the rash the general symptoms increase in severity. The injection of the pharynx and buccal mucous membrane is more intense. The tonsils are swollen and show scattered foci of exudate upon their surfaces; the pain upon swallowing is increased, and children may even complain of pain extending upward toward one or both ears. After the second day the tongue gradually loses its heavy coating, becoming, however, deeply injected; the superficial epithelium is lost; the papillæ at the tip and along the margins are more prominent, and, by the time all the symptoms are at their maximum, usually presents the characteristic "strawberry" appearance, the "*katzenzunge*" of the German writers (see Plate XXX).

The submaxillary lymph-glands are slightly enlarged, easily palpable, and more or less tender on pressure. The temperature may continue to rise, or remain at its original mark with but slight daily variation, as a rule, for from three to six days. The pulse-rate, as previously noted, remains markedly increased, and out of all proportion to the fever. The skin is tense, hot, and dry, and the urine scanty and high colored. From the second to the fourth day—in many cases even earlier—the rash begins to fade, disappearing, as a rule, in the order of its appearance; and at once an improvement in all the symptoms sets in. The temperature comes down slowly, in contrast to the abrupt fall seen in measles, and the pulse becomes slower and of better quality. The injection of the pharynx subsides, the tonsils clear up, the pain upon swallowing lessens, the appetite returns, and the child appears brighter. The skin becomes cool and moist, and, excepting for a certain loss of elasticity and a slight brownish-gold pigmentation (more marked over those areas where the eruption was most pronounced), appears natural. Desquamation commences, and by the seventh to the ninth day convalescence has been established, and advances to complete recovery unless interrupted later by some one of the dreaded complications, from which even the mildest type of the disease is not always exempt.

Stage of Desquamation (*Stadium Desquamationis*).—The desquamation of the skin in scarlatina commonly begins over those areas on which the rash was first seen, and from which it first disappears, namely: the upper thorax and neck, proceeding slowly until the

PLATE XXX.

XXX

SCARLATINA—showing eruption at its height, with "strawberry tongue."

PLATE XXXI.

PLATE XXXI.

Scarlatina, showing Eruption on the Legs.

PLATE XXXII.

PLATE XXXII.

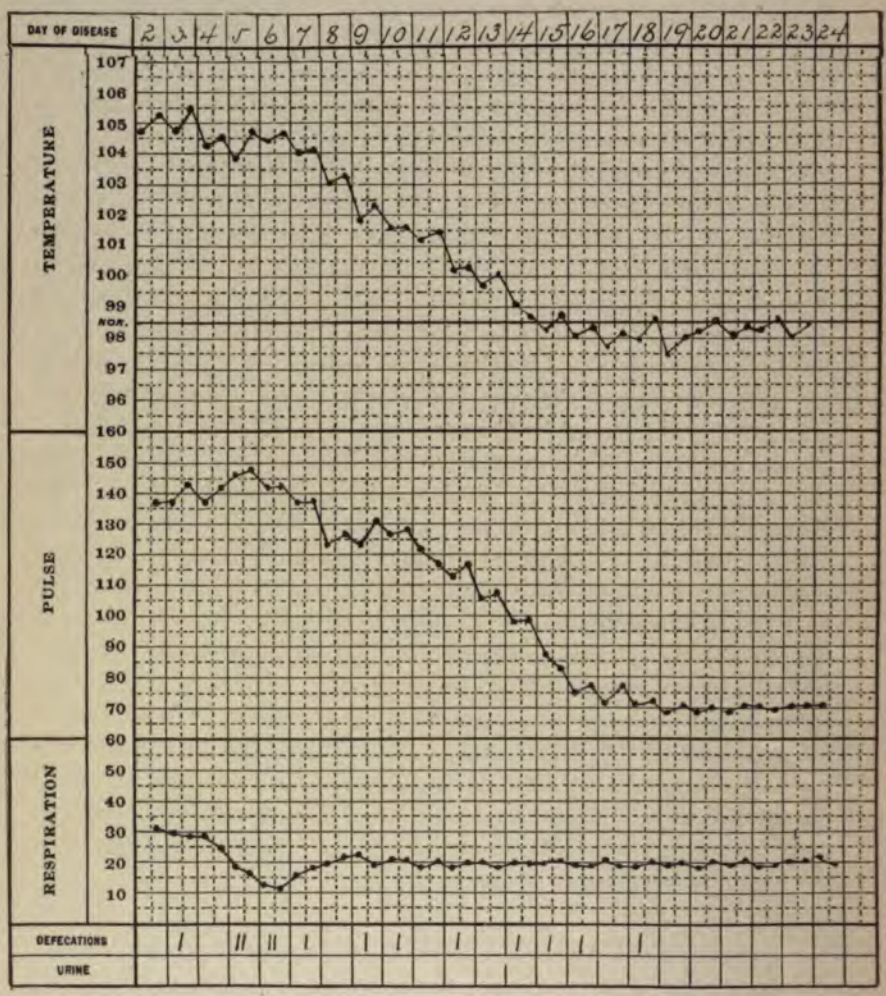
Scarlatina, showing Desquamation. (Through the Courtesy of Dr. J. F. Schamberg.)

process has included the entire body, in many instances even the face and head not escaping. It is not unusual to find the fine, scaly desquamation present upon the upper thorax while the extremities still show distinct traces of the scarlatinal rash. The character of the desquamation in scarlet fever varies with the locality, and presents two distinct types. Upon the neck, face, and trunk the scales of the epidermis are small, fine, and flaky, closely resembling those seen in measles,—*desquamatio furfuracea* (see Plate XXXII); while upon the extremities, and particularly about the hands and feet, the characteristic desquamation is best observed. The epidermis peels off, or may be stripped off in shreds of varying length, at times forming a complete cast of a finger, and in rarer instances even of a hand,—*desquamatio membranacea* or *lamellosa*. The presence of desquamating epidermis of this character about the hands or feet is, in itself, a strong proof of the previous existence of scarlatina, no matter what the history may be. The duration of the period of desquamation varies greatly, and is apparently influenced by the severity of the infection, as evidenced by the intensity of the eruption: the more intense the latter, the earlier is desquamation established, and not infrequently it lasts longer than in those cases having a less pronounced rash. It always persists longer where the epidermis is thick, as about the hands and feet; and just so long as a single flake of necrotic skin remains the patient may be a source of contagion. The length of time for the completion of the process may be said to extend from six to eight weeks: in many instances it is shorter, and in many of even longer duration. The occurrence of repeated desquamation is not uncommon. McCollom,[300] in an analysis of a thousand cases, found the average duration of this period to be fifty days, and has further noted a comparatively small number of cases of secondary, and a few cases of tertiary, desquamation. Instances in which desquamation has occurred four and even five times are reported in literature.

SEPTIC SCARLET FEVER. (*Scarlatina Anginosa.*)

This type of the disease is characterized by the severity of the initial symptoms, associated with early and marked involvement of the pharynx and tonsils, high and continued fever, and profound prostration. Cases of this character are seen more commonly in children, though adults are not exempt.

[300] McCollom: "Boston City Hospital Reports," X Series, 1889, p. 32.



Scarlatina Septica. Excessive Angina; Active Delirium from Second until the Morning of the Fifth Day. On Sixth Day Threatened Uræmia, Uræmic Twitchings, Respirations Twelve to the Minute, almost Complete Suppression of Urine. Recovery. (Writer's Case.)

From the first the headache and sore throat are intense; the local inflammation of the pharynx develops with great rapidity, severe pain and difficulty on swallowing being early and prominent symptoms.

In children there may be pronounced cerebral disturbance, extreme restlessness, convulsions, or mild delirium; while at other times abrupt and violent gastro-intestinal symptoms, with severe and prolonged vomiting, usher in the attack. The temperature rises suddenly to 105° F. (40.5° C.), or higher; the pulse becomes very rapid (140 to 160 to the minute), of small volume, and at times can only be counted with great difficulty. The thirst is extreme, while the water taken may be immediately ejected. The pharynx and tonsils are deeply injected, and early in the course of the disease the latter become acutely swollen, showing here and there scattered foci of exudate upon their surfaces. The skin is very hot, tense, and dry, and often sensitive to the touch. The scanty, concentrated urine at this time almost invariably contains albumin.

Usually within a few hours after the onset the rash appears, and in this type of the disease shows great variations. It may be seen first upon the chest or neck as small or larger faintly scarlet patches of an irregular outline, which last but a short time, disappearing, only to reappear later upon the trunk, back, or extremities. In many cases it is diffuse and of an intense scarlet or almost purple color. Again, it shows a marked tendency to stain the tissues, and even minute hæmorrhages may occur with the formation of petechiæ. In these cases the eruption is often extremely pronounced over the dorsum of the hands and feet, where it may acquire a peculiar, intensely livid hue. In cases of this type in which the rash is of a transient character, and associated with the intense local pharyngeal symptoms, the diagnosis is often extremely difficult.

With the appearance of the eruption the temperature rises beyond the initial mark, the pulse becomes more rapid, and all the local symptoms—headache, thirst, and sore throat—are much aggravated, while the constitutional depression is extreme. The mucous membrane of the pharynx is acutely inflamed; the tonsils are greatly swollen, and after the second day, in addition to the irregular covering of grayish exudate, may show, here and there, distinct necrotic areas: an appearance readily confused with true diphtheria.

The difficulty in swallowing increases, and even on the second day it may be that only liquids can be taken, while not infrequently the gastric disturbance is so severe from the onset that nothing can be

retained in the stomach. Not uncommonly the gastric irritability persists, making the problem of feeding throughout the course of the disease a difficult one, while the persistent vomiting adds to the exhaustion. The secretion of urine is diminished, albumin is present, and, microscopically, hyaline and epithelial casts and frequently blood may be found. There is great restlessness, delirium may supervene, and the prostration is profound. As the disease progresses the temperature continues elevated, assuming an irregular type and ranging between 103° and 105° F. (39.4° and 40.5° C.). The local pharyngeal symptoms increase in severity. The tongue is thickly coated, swollen, the papillæ prominent and the tip and edges reddened, and it early assumes the characteristic appearance. The inflammation and necrosis of the tonsils advance, and are followed by ulceration, with extensive sloughing, the discharge of broken-down exudate and tissue, causing, as a rule, the most distressing cough, associated with profuse expectoration. The neighboring chains of lymphatic glands are acutely swollen, easily palpable, and tender. In some cases an excessive infiltration of the cellular tissue of the neck takes place, which is occasionally so marked that the overstretched tissue encircles the neck as a collar.

The local pharyngeal inflammation may even extend to the posterior nasopharynx, with the development of a muco-purulent discharge from the nares, which is intensely irritating to the skin, giving rise to the formation of rhagades about the nostrils and lips; or it may extend along the Eustachian tubes, involving one or both ears, with subsequent rupture of the membrana tympani and discharge of the purulent accumulation.

The secretion of urine diminishes. At times it is almost suppressed, and not infrequently, by the fourth or fifth day, slight or pronounced uræmic twitchings are seen. The pulse is weak and rapid (130 to 150 to the minute) and frequently irregular: always a grave sign in scarlatina.

In this type of the disease the heart-sounds may early lose their normal tone and character, the first sound particularly being weak, while not uncommonly, by the fourth to the sixth day, the two sounds may be indistinguishable. Less commonly, transitory murmurs are heard, and more rarely, actual dilatation of the heart may be made out.

Not infrequently by the sixth to the seventh day—after the symptoms have persisted as above, often with pronounced cerebral disturbance, as evidenced by great restlessness with active delirium, or again

by extreme apathy and stupor, the clinical picture being that of a grave septicæmia—there is a change for the better, and the turning-point in the attack is reached. In many cases of this type which recover the improvement in the symptoms is not seen, however, until late in the second week. The temperature falls; the pulse becomes less rapid, regular, and of better quality; and the cerebral symptoms gradually improve: though not uncommonly, following a period of active cerebral disturbance, associated with great prostration, mild recurrent delirium, coming on toward evening, may persist for three or four days. The local ulcerative process in the pharynx is checked and improves slowly. The inflammation of the lymphatic glands subsides. The secretion of urine becomes more abundant; and early in the third week desquamation begins, and convalescence—though in such cases prolonged beyond the so-called normal period—is gradually established. In these cases desquamation frequently advances slowly, and may be still incomplete by the twelfth week, rarely later, being present at this time between the fingers and toes.

In cases which prove fatal, either directly through the overwhelming toxæmia, or indirectly, from the development of some intercurrent complication, which, if present, may be detected, as a rule, by the physical signs, or subjective symptoms, the course of the attack is frequently more abrupt. The temperature early becomes more irregularly septic in type, with a daily variation of three or more degrees, ranging between 103° and 106° F. (39.4° and 41.1° C.) or even higher; the pulse grows weaker, more rapid, and irregular; the respirations may be quick and short, or slow and labored; the local ulceration in the pharynx is extreme, and the constitutional depression profound. The condition of the patient is one of marked stupor and apathy, or less commonly there is great restlessness, which gives way to active delirium, followed later by coma; while frequently toward the close of the attack a profuse diarrhœa sets in, together with a critical diaphoresis, and the patient succumbs to the severity of the infection, late in the first or early in the second week of the attack.

TOXIC SCARLET FEVER.

(*Scarlatina maligna*; *la scarlatine foudroyante.*)

This type of the disease, fortunately rare (occurring only in about 2 per cent. of all cases of scarlatina), is characterized by the great abruptness of its onset, associated from the first with an overwhelming

intoxication by the scarlatinal poison, excessively high temperature, pronounced cerebral disturbance, a grave tendency to the occurrence of hæmorrhages into the skin and from the mucous surfaces, and profound prostration, and usually proves fatal within the first three days.

Under this head are included the ATAXIC, ADYNAMIC, and HÆMORRHAGIC FORMS. The onset is abrupt and explosive; a child, to all appearances well, is seized with a sudden and violent attack of vomiting, associated occasionally with an abrupt and profuse diarrhœa, or again severe and prolonged convulsions are the first indication of the infection. The temperature rises rapidly, reaching 105° to 107° F. (40.5° to 41.6° C.) within the first few hours and frequently higher, temperatures of 110° F. (43.3° C.) and even 111° F. (43.8° C.) having been recorded. The pulse becomes very rapid (140 to 160 to the minute), weak, irregular, and intermittent. The cheeks and lips are blanched, and may early show slight cyanosis. The urine is scanty, high colored, albuminous, or may be completely suppressed.

Following the initial symptoms, the condition of the child rapidly becomes alarming. The cerebral disturbance is extreme, the headache is intense, and the convulsions give way to active delirium. There is frequently marked dyspnœa, the respiratory rhythm being short and quick, due usually not to any change in the lungs at this time, but probably to irritation of the respiratory centres, as emphasized by Ausset.[301]

The local pharyngeal inflammation may be severe, though frequently masked by the intensity of the general symptoms; again, it is wholly wanting, the course of the disease progressing with such rapidity as to prove fatal before pronounced development of the local angina. The eruption appears early, is diffuse and general in distribution, or irregular and of a brilliant or dusky color, patchy and fleeting in character, while at times it is so evanescent as to seem wholly wanting. Quickly following the early development of the attack coma develops and the child sinks rapidly, succumbing—not infrequently within forty-eight hours—to the intense toxæmia.

The so-called *ataxic* and *adynamic* forms are characterized by early and profound constitutional depression,—the result of the direct action of the specific toxin upon the nerve-centres,—the symptoms rapidly assuming a grave typhoidal type.

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[301] Ausset (E.): "Leçons Cliniques sur les Maladies des Enfants" (Paris, 1895), p. 251.

The temperature rises abruptly, the pulse becomes weak, rapid, irregular, and easily compressible; and the respirations rapid and shallow. The mouth soon becomes parched, the tongue dry, and the lips cracked. The bowels are loose, the movements frequently being passed involuntarily; and the secretion of urine is greatly diminished or completely suppressed.

A low delirium followed by coma rapidly ensues, and the case often ends fatally before the appearance of the exanthem or marked development of the angina.

In the *hæmorrhagic forms* characterized by the occurrence of hæmorrhages from the mucous surfaces, and into the skin, the eruption is, for the greater part, but imperfectly developed. The exanthem early acquires a dark purplish hue, and is not readily obliterated by pressure, showing a marked tendency to stain the tissues. Within the first forty-eight hours small petechiæ, varying in size from a pin-head to a lentil, with a sharply defined margin, appear scattered irregularly over the body. The lower extremities, or the trunk alone, may be involved, while the arms and neck remain free. At the same time petechiæ may be seen upon the mucous membranes of the gums, or epistaxis may occur.

In the grave forms of this type of the disease the tendency to hæmorrhages from the mucous surfaces is greatly increased. Early and persistent vomiting not uncommonly suggests the nature of the attack, the vomitus being frequently at this time dark in color.

The petechiæ already described appear, and may coalesce over a limited area, or fresh deep purple ecchymoses, of a large size, develop on various parts of the body. Blood oozes from the gums, the sputum being even tinged with it, while the epistaxis may be severe. Blood is discharged from the bowels, or the stools may be tarry in color. Hæmorrhages occur from the genito-urinary tract, or the urine shows the presence of blood in great excess. Rarely the pleuræ or pericardium may be the seat of extensive hæmorrhagic exudation.

The skin which may show elsewhere a faint or deeper scarlet blush, becomes flabby and wrinkled, while in rare instances the face may be actually bloated.

The pulse is weak, rapid, and easily compressed; the respirations hurried, and the patient usually sinks quickly into a state of profound collapse.

Death is, in these cases, the almost invariable result, occurring not infrequently within ten or twenty hours after the onset. Recovery is

possible, according to Thomas, in the milder types of this form of the disease.

As a rule, young children between one and two years of age, with but poorly developed constitutions and greatly lowered vitality, are the subjects of this form of scarlatina, though older children may be attacked, and even adults are not wholly exempt.

IRREGULAR FORMS OF SCARLET FEVER. (*Scarlatina Modificata.*)

Any classification of the many clinical types of scarlatina into one of the above distinct groupings must remain of purely theoretical value. So great is the variation in each case that not infrequently the three types of the disease may run together, making a sharp differentiation impossible. Considering the simple type—scarlatina simplex—as the normal, all other forms are essentially irregular, and are so classified by many observers.

Other well-recognized irregular or anomalous forms may be divided into those in which: (*a*) the eruption is almost, if not wholly, absent; (*b*) those in which the chief marked variation is in the unusual or abnormal character of the eruption; (*c*) those forms characterized by irregularities in, or complete absence of, any marked rise in the temperature; and (*d*) those cases in which the angina is of unusually mild degree.

(A) SCARLATINA SINE EXANTHEMATA.—Mayr states (*loc. cit.*, p. 195) that this expression is only justified in those cases in which, in a given group or family, otherwise typical attacks of scarlatina occur, associated with angina and fever without eruption, and consequent desquamation. Thomas (*loc. cit.*, p. 251) in describing the "rudimentary" and "mild" forms says that every throat affection during a scarlet-fever epidemic should be regarded with suspicion, and, further, in the absence of satisfactory etiological evidence, the scarlatinal nature of the attack may be proved by the subsequent occurrence of the characteristic desquamation, even when there has been no previous trace of an eruption, or by the appearance of a moderate amount of dropsy with albuminuria. Henoch[302] holds that many cases of scarlatina do undoubtedly occur in which the eruption, though rarely completely absent, has been overlooked, being either so scanty or of such a super-

[302] Henoch (Ed.): "Charité Annalen," III Jahrgang, 1876, p. 553. "Mittheilungs ueber das Scharlachfieber," and Vorlesung. (*loc. cit.*), p. 861.

ficial erythematous type as to be thought of no especial significance; "and that only a subsequent nephritis or a true desquamation renders the diagnosis in these cases positive." That instances do occur in which the eruption is wholly absent is the opinion of many observers, and that there are many cases in which the rash is of such an evanescent character that it entirely escapes notice must be admitted. The difficulty of diagnosis in these instances may be extreme, the occurrence of a characteristic desquamation being by no means an absolutely infallible sign of the previous existence of scarlet fever, while the nephritis may be absent.

(B) SCARLATINA LÆVIS.—This term applies to the form of eruption seen in the ordinary mild or simple type of the disease.

SCARLATINA LÆVIGATA.—Canstatt (see Mayr, *loc. cit.*, p. 195) has given this name to a variety of the exanthem of a more intense character than the simple type. In these cases the rash acquires a peculiar shining, glossy appearance, and the mucous membranes are markedly involved.

SCARLATINA MILIARIS (*Scharlachfriessel*).—In this type of the eruption small vesicles containing a clear, white fluid of alkaline reaction develop, being seen chiefly on the trunk, though occasionally also upon the extremities and scattered over the body. According to Eichhorst (*loc. cit.*, iv, p. 256), the occurrence of this form of the exanthem is especially favored by profuse sweating, though it appears independently of it, as a sequel to an extensive exudation between the rete Malpighii and the epidermis. In some instances the single vesicles become larger, simulating herpes, or they may even acquire varicella-like and pemphigoid forms.

SCARLATINA PAPULOSA. — In cases thus named small, slightly-elevated papules of a dark-red color develop at the site of the hair follicles as a result of an unusual exudation into the mouths of the hair sacs. Occasionally they are more readily detected by the finger than by the eye, and in some instances (Mayr, *loc. cit.*, p. 196) are observed twelve to eighteen hours before the ordinary scarlatinal rash appears.

SCARLATINA HÆMORRHAGICA (*seu Septica*).—This type of the eruption, as has been described under the toxic forms of scarlatina, is characterized by the presence of hæmorrhages from the mucous surfaces and into the skin; and is, of course, to be differentiated from those in which small isolated hæmorrhages occur in the skin, but are of no especial significance.

SCARLATINA VARIEGATA.—This form is marked by an extremely irregular distribution of the eruption frequently associated with the development of well defined macular areas of an intense-red color situated at the sites of the hair follicles, and in many instances simulating the exanthem of measles. Between these macular spots of bright red the skin is generally covered by a uniform, but pale, rash. Rarely these macules coalesce, while more commonly they undergo no alteration. Henoch (Vorles, *loc. cit.*, p. 650) is of the opinion that the appearance of this type of the eruption is usually indicative of an unfavorable course of the disease, though this is not always the case.

In any large number of cases, in addition to these well-recognized irregular forms, a great variation is seen in the duration of the eruption, which may be unusually prolonged, lasting, in some instances, even from one to two weeks. Again, a fresh outbreak of the eruption, following an almost complete desquamation of the skin, may occur though probably this secondary rash is, in the majority of instances, more of the nature of an erythema than a true scarlatinal eruption.[303]

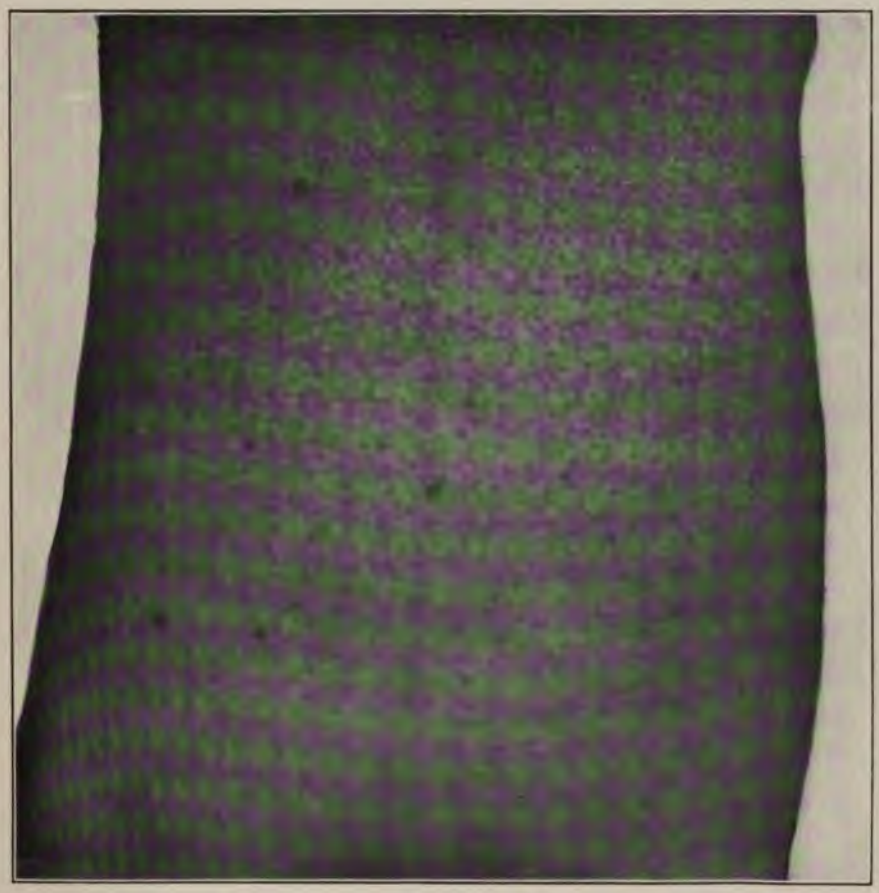
(C) SCARLATINA SINE FEBRE.—Among the extremely mild cases of scarlatina instances are frequently seen in which, after a slight initial rise, the disease progresses without any subsequent elevation of temperature beyond 98.5° to 99° F. (36.5° to 38° C.), while every other symptom of the disease is present, though in a mild degree. That cases occur which would admit of the literal interpretation of this definition—*i.e.*, without any fever—is extremely doubtful, and Wunderlich[304] has pointed out the difficulty of determining this point, due to the fact that these extremely mild cases are rarely seen at the outset. In McCollom's series there were thirty-seven cases with a temperature of but 99° F. (38° C.), and many such cases are reported in literature. Other well-marked irregularities in the course of the temperature are seen but rarely, there being in some few instances (4 cases in 175, Henoch) a pronounced daily intermission, the temperature falling to normal in the morning associated with a high evening rise. Less commonly cases are seen in which, after the temperature has remained for a few days between 100° and 101.5° F. (39° and 40.5° C.), it falls abruptly to normal, and the subsequent course of the disease continues without any further elevation. Under the head of fever of an "In-

[303] Kaposi (M.): "Path. u. Therapie der Hautkrankheiten" (Berlin und Wien, 1899), p. 236.

[304] Wunderlich (C. A.): "Das Verhalten der Eigenwarme in Krankheiten" (Leipzig, 1870), p. 330.

PLATE XXXIII.

PLATE XXXIII.



Scarlatina and Varicella Co-existing.

verted Type" Henoch ("Char. Annal.," *loc. cit.*, p. 513) has further described the occurrence of a temperature curve quite the reverse of the normal, in which the temperature was higher in the morning than in the evening.

(D) SCARLATINA SINE ANGINA.—This term has been applied to those cases of unusually mild degree in which the subjective throat symptoms are very slight, or so insignificant as to appear wholly wanting. In these cases there is always some congestion of the throat, and usually a faint enanthem can be made out early in the course of the disease. The tonsils are not enlarged, but there is an almost constant, even though slight, enlargement of the papillæ at the tip and edges of the tongue: a point frequently of no little diagnostic value.

OCCURRENCE OF SCARLATINA WITH OTHER ACUTE EXANTHEMATA.—It has been well established by a large number of carefully reported cases that the existence of scarlet fever in an individual does not prevent a secondary infection with any of the other acute exanthemata, —such as measles, chicken-pox (see Plate XXXIII), or small-pox (*q. v.*, p. 81),—although it must be acknowledged that this is exceedingly infrequent. When such coincidences do occur, however, it has been observed that the secondary infection takes place late in the course of the first, and most frequently after all traces of the primary exanthem have disappeared, and the eruption of the secondary disease predominates. It is claimed by some, that occasionally the eruption of measles, chicken-pox, or even small-pox may be present together with the scarlatinal rash, so that three distinct exanthemata may occur simultaneously. This, however, we have never seen. When the primary affection has entirely subsided the appearance of another acute exanthem does not, as a rule, greatly modify the one or the other. Murchison (*Lancet, loc. cit.*), however, has well emphasized the fact that, when two exanthemata co-exist, one is usually mild and more or less ill defined. This is liable to lead to great confusion in diagnosis, and, while the possibility of the co-existence of two distinct exanthemata in the same individual should not be lost sight of, the frequency of prodromal scarlatiniform rashes in variola, and to a less extent in rubeola, must constantly be borne in mind.

The existence of other cutaneous affections during the period of the scarlatinal eruption is not uncommon, and may be evidenced by simple or toxic erythemas, by the presence of an urticarial rash, or by single scattered vesicles, pustules, or petechiæ, which are dependent, except in the case of the toxic erythemas, upon a local alteration in

the tension of the blood-vessels with unusual permeability and exudation from them. In the hæmorrhagic or septic type the condition is one of true purpura co-existing with the scarlatinal rash.

The chronic diseases of the skin, such as eczema and psoriasis, usually subside in intensity during the period of eruption in scarlatina, increasing again in activity with the establishment of convalescence. Even in scabies we have often remarked that the itching seems to be less severe, if not wholly absent, during an attack of scarlatina. It does not, however, impair the vitality of the Acarus.

COMPLICATIONS.

The Throat.—The early and marked involvement of the pharynx and fauces in scarlatina, while essentially a symptom of the infection as seen in the mildest type (angina scarlatinosa simplex), may constitute one of the gravest complications of the disease, leading to severe ulcerations with far-reaching and disastrous results. Although it is highly probable that, under certain circumstances, the scarlatinal virus alone is capable of producing inflammation of the pharyngeal mucous membrane associated with more or less necrosis, yet in all those cases characterized by extensive destruction of the tissues, or by the formation of a false membrane, as well as in many of the less severe types, the presence of known pathogenic micro-organisms has long since been well recognized.

In this connection von Jürgensen (*loc. cit.*, p. 130) holds that, so long as we know nothing of the specific cause of scarlatina it is impossible to determine in how far the scarlatinal virus, unassociated with other pathogenic microbes, is responsible for the severer forms of necrotic inflammation. At the same time he expresses his belief that the scarlatinal poison is in itself capable of giving rise to such inflammatory reaction. Moreover, Henoch (*loc. cit.*, *Vor.*, pp. 661 *et seq.*) lays great stress on the tendency to such inflammations with necrosis—"*necrotisirenden Entzundungen*"—as a result of the specific scarlatinal infection.

The great confusion which existed for many years with reference to the etiology of the pseudomembranous anginas in scarlet fever has been done away with. The researches of many investigators[305] in Europe, as well as in this country, have definitely established the fact

[305] Loeffler: Deut. klin. Woch., Nos. 39 and 40, 1890. Bourges and Wurtz: Prog. Méd., May 10, 1890. Bourges: Gaz. Hebd., No. 13, 1891, *et al.*

that the Klebs-Loeffler bacillus is absent in a great majority of cases in the early scarlatinal angina, occurring very rarely in combination with the streptococcus pyogenes, which is almost constantly present. Lemoine,[306] in a bacteriological study of 117 cases of scarlatinal angina, found the streptococcus pyogenes alone in 93, while the Klebs-Loeffler bacillus was found, in addition, in 5, and the bacillus coli communis in 9 cases. The staphylococcus pyogenes aureus is found occasionally, and more rarely other pathogenic micro-organisms, together with the streptococcus. It has thus been definitely proved that the streptococcus is the main etiological element in these cases.

Under circumstances favoring the exposure of the individual to the contagion of diphtheria, the presence of Klebs-Loeffler bacilli in the pharynx at this time might naturally be the result, and the local process should then be regarded as essentially a true diphtheria complicating *early* scarlatina, which is, however, a rare occurrence.

Aggravated *angina scarlatinosa simplex*—while not, in reality, a true complication—may be justly considered as such, in those instances in which it persists beyond the normal, causing a prolongation of the febrile period, and an aggravated local inflammation, without other serious manifestation.

Angina Pseudomembranosa (*of Streptococcic Origin*).—Cases characterized by the development of a false membrane upon the tonsils and in the pharynx are seen in the severe or septic type of the disease, in which the local pharyngeal symptoms early acquire unusual prominence.

By the second day the mucous membrane of the pharynx is intensely reddened and congested, the tonsils, which are much inflamed and swollen, show here and there scattered, irregular, patches of gray or grayish-white exudate, completely occluding the tonsillar crypts over a more or less limited surface. The neighboring lymphatic glands are enlarged, readily palpable, and tender. One or both tonsils may be involved, and, while it is commoner to find both sides affected, the process may be more pronounced on one side. In many cases the local process is limited to these irregular patches of exudate, which remain sharply defined on the tonsils; or, again, small foci may be seen upon the soft palate, causing, in either case, but slight destruction of tissue. In these less extensive cases after five or six days resolution begins, the patches

[306] Lemoine (G. H.): "Rôle du Streptococque dans la Scarlatine et ses Complications." Bull. et Mém. de la Soc. des Hôp. de Paris, 1895; *ibid.*, 1896, iii, S. xiii, 303-319. See Soc. Proceed. Gaz. des Hôp., December 24, 1896, p. 1449.

character of the epidemic, and to a certain degree with the age of the individual attacked. As a rule, it can be said that, the younger the child, the greater is the danger of otitis, the liability diminishing with each added year. The mild or catarrhal form of otitis media, according to Bader and Guinon,[307] is very common, occurring in 33 per cent. of all cases of scarlet fever, while the purulent form is less common, occurring in but 4.5 per cent. In Caiger's[308] analysis of 4015 cases of scarlatina the percentage given for the occurrence of otitis media with discharge is 11.05. That it is much more frequent in cases accompanied by severe throat symptoms must be admitted. Holt[309] places its occurrence as high as 75 per cent. in the severe cases. It may develop at any time during the scarlatinal attack, after the first two or three days, and in cases accompanied with marked involvement of the pharynx very commonly appears about the end of the first week. As a rule, when one ear is affected, the other side does not escape, although both ears are not affected simultaneously.

In many cases when it develops at the height of the disease, and particularly in young children, there is danger of its being overlooked during the early stages, and it often happens that it is not until the appearance of the discharge from the external ear that the existence of this complication is discovered. Frequently children may excite suspicion through their cry, or by repeatedly carrying their hands to the head, but only in an indefinite way; while, again, many small children give no such clue, and even in older children, with the absence of marked pain, the accompanying deafness may escape notice, and the unusual duration of or unexpected rise in the temperature may be the first indication of the local trouble.

Coincident with the extension of the inflammation from the pharynx along the Eustachian tube, there occurs marked congestion and swelling of the mucous membrane of this canal, resulting in occlusion of its lumen, which prevents the escape of any exudate formed, thus giving rise, in a large measure, to the resulting symptoms.

These are evidenced, early in the attack, by pain in the affected ear, tenderness over and about the external auditory canal, slight or marked rise in the temperature, or persistence of the existing tem-

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[307] See Moizard: "Scarlatine," in "Traité des Mal. de l'Enfance" (Paris, 1897), vol. i, p. 143.

[308] Caiger (F. F.): "Scarlet Fever," in Allbutt's "System of Medicine" (New York, 1897), vol. iii, p. 150.

[309] Holt (L. E.): "Diseases of Infancy and Childhood" (New York, 1897), p. 101.

perature curve. The lymphatic glands in the immediate neighborhood of the ear are enlarged, palpable, and may be tender.

These symptoms persist for three or four days, when, unless relieved by incision, the membrana tympani ruptures spontaneously, following which there is often seen an immediate and marked improvement, the pain and tenderness disappearing, while the fever quickly subsides. In the less severe cases the rupture or incision of the tympanic membrane, with the escape of the contents from the middle ear, marks the turning-point in the affection, which then, under appropriate treatment, improves slowly, the discharge ceasing after three or four weeks, while the incision in the membrana tympani heals rapidly, without marked disturbance of hearing.

In those instances in which the inflammation of the middle ear becomes purulent ("suppurative otitis media") the condition is one of great seriousness, the result being all too frequently total deafness. This complication is seen in the severe types of scarlatina associated with grave scarlatinal angina, while the subjective symptoms remain as in the simple form, with an added irregularity in, or unusual elevation of, the temperature curve. Externally, early examination reveals a marked injection of the blood-vessels of the tympanic membrane. The membrane itself becomes swollen, cloudy, and of a yellowish-red color; its edges cannot be sharply defined, the handle of the malleus is obscured, and there is even swelling and injection of the deeper parts of the external auditory canal. Unless relieved by prompt incision, perforation occurs in from two to three days, with, in some instances, immediate improvement of the symptoms. In many cases, however, the inflammatory process is of such an extreme grade that total deafness results, with the establishment of a chronic otorrhœa, which may lead to subsequent serious complications. The amount of destruction which follows suppurative otitis varies from partial loss of the tympanic membrane, with greatly diminished hearing on one or both sides, to complete destruction of the membrana tympani, together with one or more of the bones of the tympanic cavity, and extensive ulceration or even necrosis of the tympanum. As a result of chronic otorrhœa, inflammation of the mastoid cells, paralysis of the facial nerve, sinus-thrombosis, meningitis, and even abscess of the brain may ensue.

Of 85 cases of ear disease resulting from scarlet fever, Burckhardt-Merian[310] found both ears affected in 72 cases (84.7 per cent.), and,

[310] Burckhardt-Merian: "Ueber den Scharlach in seinen Beziehungen zum Gehörorgan." Von Volkmann's Klinisch. Vorträge, No. 182 (Chirurgie, No. 54), p. 1489.

further, among 4309 cases of acquired deafness, 444 (10.3 per cent.) were referable to scarlet fever.

Empyema of the *mastoid antrum*, as a result of chronic suppurative otitis media, occurs in a small percentage of all cases. With the establishment of a communication between the tympanic cavity and the cells of the mastoid, there is usually a slight decrease in the amount of the discharge from the ear, the temperature rises to 104° F. or higher, and shows a more marked fluctuation. There is pain referred to the mastoid region, with tenderness, more or less pronounced, over the mastoid process. There may be a slight rigor. The pulse becomes rapid, and may be irregular, while there is commonly great restlessness and irritability. These symptoms persist, with varying intensity, from day to day, and, unless relieved by operation, these cases may end fatally, due to the development of meningitis.

More rarely an inflammatory swelling appears behind the external ear, situated over the mastoid, associated with a rise of temperature, extreme local tenderness, and, in a certain number of cases, œdema of the eyelids on the same side, with more or less projection forward of the ear; and, occasionally, actual local suppuration and abscess-formation takes place. This is due either to a periostitis or a local adenitis, which may be remotely dependent upon the otitis media.

The Lymphatics. Phlegmonous Inflammation of the Neck. Diffuse Cellulitis. Angina Ludovici (*"Tippet Neck"*).—The enlargement of the lymphatic glands of the neck is usually marked early in the course of scarlatina, the increase in size of the maxillary and submaxillary glands being particularly constant, indeed, occurring in 95 and 36 per cent., respectively, of all cases of scarlet fever.[311] The posterior cervical glands, while showing some enlargement in 77 per cent., never attain any great size, and, owing to their situation, play but an unimportant rôle. In cases of moderate severity the enlargement of the lymphatic glands never reaches an extreme degree, and, with the establishment of convalescence, resolution sets in. In the more severe forms of scarlatina—those particularly characterized by early and intense involvement of the pharynx—the swelling of the neighboring lymphatic glands may be extreme. They become tense, hard, and resistant, and may even reach such a degree of enlargement as to interfere with the movements of the head. In some instances the parotid glands, as well,

[311] Schamberg (J. F.): "A Clinical Study of the Lymphatic Glands in One Hundred Cases of Scarlet Fever." Ann. of Gynecology and Pediat. (Boston), December, 1889, vol. xiii, p. 39.

are involved. In not a few cases the enlargement of the maxillary and submaxillary glands persists, and, passing beyond the first stage of inflammation, suppuration occurs, giving rise to the so-called phlegmonous inflammation.

Phlegmonous Inflammation. — The resulting maxillary and submaxillary abscesses constitute always a serious complication, and, unless opened and drained, may lead to hæmorrhages from the large vessels of the neck. Even when freely incised there is always danger of the pus burrowing beneath the connective tissue, and giving rise ultimately to some unlooked-for and added complication. In other instances there may develop, coincidently with or immediately following the suppurative process, a rapid and diffuse cellulitis, with excessive infiltration of the deeper tissues of this region.

Angina Ludovici (*"Tippet Neck"*).—This may occur by the fifth day of the disease, though more commonly it is seen early in the second week of the attack. The skin is indurated, tense, and glossy, and may pit on pressure, though giving no sense of fluctuation. The process may be limited to the angles of the jaw or involve the entire neck; it may extend downward to the clavicles and upward along the sides of the face and head, rendering the head almost, if not wholly, rigid. Associated with the phlegmonous inflammation of the lymphatic glands in the neck, this diffuse cellulitis of the deeper tissues constitutes one of the gravest complications of scarlet fever, proving almost invariably fatal. Death results from a rupture of one of the large vessels,—jugular vein or internal carotid artery,—or as a result of thrombosis or embolism, with fatal meningitis or pyæmia.

The involvement of the superficial lymphatic glands, as well as of all the lymphatic tissues of the body in scarlet fever, depends upon the character and the intensity of the infection, being more pronounced in cases of extreme toxæmia, though present in a less degree in the milder types of the disease.

That the scarlatinal virus alone is capable of giving rise to great enlargement and even actual hyperplasia of the lymphatic structures, not only of the lymphatic glands, but of the single and agminated follicles as well, is clearly established by the changes seen in those cases which, succumbing early in their course to the severity of the scarlatinal infection, show post-mortem a marked increase and proliferation of all the lymphatic tissues, with little or no other marked pathological alteration.[312] The spleen in scarlet fever is frequently enlarged

[312] See von Jürgensen (*loc. cit.*, pp. 70-80, Cases II to VI).

and readily palpable at the margin of the ribs, and may even attain early in the attack double its normal size, while, with the existence of a secondary infection, as would be expected, it may be greatly increased in size.

Though the enlargement of the superficial lymphatic glands includes all those groups readily palpable, it is most constantly seen in the glands situated beneath, and at the angle of, the jaw, giving rise, in many cases, as noted above, to extreme glandular infiltration, and even suppuration, being particularly marked in those cases associated with severe throat symptoms (phlegmonous inflammation, angina Ludovici). The enlargement may be unilateral; more commonly it is bilateral, and varies in size from a small, readily palpable mass, measuring about an inch (2 to 3 centimetres) in diameter to a large tumor of about two inches (4 to 5 centimetres) in diameter, or larger.

Following the excessive suppuration of the lymphatic glands of the neck, and as a direct sequence, conjunctivitis, necrosis of the cornea, and even destruction of the entire bulb may ensue. In addition, erosions into the large vessels of the neck, phlebitis with the formation of thrombi, and rarely direct openings into the pharynx, or a retropharyngeal abscess are among the complications. Bókai[318] has recorded six cases of retropharyngeal abscess as a result of lymphadenitis, out of 664 cases of scarlet fever.

In a recent study of the lymphatic glands in scarlatina, Schamberg (*loc. cit.*) found that the various groups of lymphatic glands were enlarged in the following proportion in a hundred cases:—

Inguinal glands	100 per cent.
Axillary	96 " "
Maxillary	95 " "
Posterior cervical	77 " "
Anterior cervical	44 " "
Submaxillary	36 " "
Epitrochlear	26 " "
Sublingual	25 " "

As a result of the analysis of these hundred cases he finds that the maxillary glands commonly attain the largest size, and also most frequently undergo suppuration. In all cases examined on the second and third day of the disease the enlargement of the lymphatic glands was well marked.

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[318] Bókai (J., Sr.): "Ueber Retropharyngealabscesse bei Kindern." "Jahrb. f. Kindh., N. F.," vol. x, pp. 108 *et seq.*

Involvement of the Joints.—Acute articular rheumatism may occur coincidently with the development of an attack of scarlet fever, though more frequently it is seen as a complication arising during convalescence, and differs in no way from an ordinary attack of rheumatism uncomplicated by scarlatina. An attack of scarlet fever during convalescence from rheumatism frequently causes a relapse of the rheumatic affection.

Scarlatinal synovitis (so-called *scarlatinal rheumatism*, or "pseudorheumatism") is a comparatively common complication of scarlet fever, showing, however, a great variation in the frequency of its occurrence in different epidemics. In a series of 500 cases of scarlatina reported by Ashby[314] there were but 10 mild cases, or 2 per cent., and but 2 severe cases. In 3000 cases of scarlet fever Hodger[315] noted 117 cases of scarlatinal synovitis, or 3.2 per cent. There has long been a great difference of opinion as to the exact nature of this affection, but, according to the commonly accepted view of the present day, it is held that it is not identical with true articular rheumatism, being regarded as an independent, pseudorheumatic infection, differing clinically from the former in that it shows less tendency to migrate from joint to joint, while, ordinarily, fewer joints are involved. Furthermore, the characteristic acid sweats of true rheumatism are absent, relapses are less frequent, its occurrence in individuals with a distinct rheumatic history is not more frequent, and the cardiac complications which follow genuine rheumatism are much less common. Two distinct forms may be recognized: (*a*) *simple catarrhal* or *serous synovitis*, and (*b*) *suppurative* or *purulent arthritis* (a condition of far greater rarity than the simple form). The streptococcus pyogenes has been found in both forms in pure culture, and occasionally in combination with other micrococci.

Simple scarlatinal synovitis is seen more often in young adults than in infants and children, increasing in frequency after the fifth year and occurring but rarely under the age of three (Holt, *loc. cit.*, p. 902). Any of the joints may be attacked, though the small joints, particularly those of the hands and wrists and of the ankles and feet, are involved more frequently than the larger articulations.

In rare instances the cervical vertebræ are invaded, giving rise, in some cases, to contractures of the cervical muscles. It occurs usually at the end of the first, or beginning of the second, week, while,

[314] Ashby, H.: Brit. Med. Jour., 1883, vol. ii, p. 514.
[315] Hodger: See Eichhorst (*loc. cit.*, p. 241).

at other times, it may not develop until late in the second, or early in the third, week of the disease. The symptoms referable to the mildest forms are: vague pains in the affected joints; swelling, which may or may not be marked, with but slight impairment of motion; some redness, and occasionally a slight rise of temperature. As a rule, these symptoms persist for from three to four days, and then disappear entirely. In more severe, but exceptional, cases, the pain, swelling, redness, and immobility of the joint may be extreme and associated with high fever, and more pronounced constitutional disturbance.

In a few cases the large joints (knee or shoulder) may remain swollen for some weeks, owing to the effusion of serum. According to von Jürgensen (*loc. cit.*, p. 161), the constant uniformity of the local process in the involved joint, which persists steadily while the attack lasts and shows no such fluctuation as is seen in true articular rheumatism, is peculiarly characteristic of scarlatinal synovitis.

Suppurative synovitis, or arthritis, as a complication of scarlatina, usually developing late in the course of the disease and involving the large joints, is of extremely rare occurrence, but may arise, according to Henoch (*Vor., loc. cit.*, p. 658), either through the local development of suppuration in the involved joint,—the least frequent form,—remaining, in these cases, limited to a single joint; or as the result of emboli, following septicæmia, involving a number of joints and always resulting in death. The commonest source of the septicæmia in these cases is the ulcerative and necrotic processes in the pharynx.

Bókai[316] has seen the local process following a scarlatinal arthritis become chronic, with resulting so-called "white swelling" of the joints: a secondary tuberculous infection, occurring as a sequela of the scarlatinal inflammation. Exceptionally, the larger joints may be further involved by the development of periarticular abscesses, which may lead subsequently to a communication into the joint-cavity.

Instances of marked ankylosis, and even deformity, following scarlatina,—affecting the ankles, knee, elbow, and phalangeal joints,—are reported in literature.[317]

Involvement of the Kidneys.—No complication of scarlatina is more uncertain, and at the same time more grave from the stand-point of its possible results, than the occurrence of nephritis, while as a factor in the development of acute nephritis, particularly in childhood, scarlet

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[316] Bókai (J., Jr.): "Ueber die Scarlatinosen Gelenkentzundungen." "Jahrb. f. Kindh., N. F.," vol. xxiii, 1885, pp. 304 *et seq.*

[317] Richardière et Peron: See soc. proceed. Gaz. des Hôp., December 5, 1893, p. 1318.

fever is the most important, no case, however mild, being wholly free from the danger of a subsequent serious renal inflammation.

Clinically, we may differentiate the conditions arising as a result of the involvement of the kidneys, into three groups:—

1. Transient febrile albuminuria, and the initial catarrhal nephritis. 2. Septic nephritis. 3. Post-scarlatinal nephritis.

The presence of a *transient albuminuria* early in the course of scarlatina is of very frequent occurrence, being seen in from 77.6 to 92 per cent. of all cases.[318] In the vast majority of instances it differs in no way from the febrile albuminuria seen in all acute infections associated with more or less elevation of temperature. It appears usually on the second or third day, lasts but three or four days, and disappears at the end of the first week, with the subsidence of the fever. This complication is of no especial significance, as it does not depend on any pathological alteration in the structure of the kidneys.

Initial catarrhal nephritis not infrequently occurs in the first week, in cases of moderate severity: *i.e.*, in contradistinction to those which prove fatal within the first two or three days. The urine, in addition to the presence of albumin, shows, microscopically, degenerated epithelial cells, mucous cylindroids, and, in rare instances, epithelial or even hyaline casts, with occasionally a few red and white blood-corpuscles. In addition to these microscopical findings, Friedländer[319] has noted clinically, in a few exceptional instances, slight traces of œdema. These symptoms have been interpreted as evidence of an early catarrhal inflammation—"acute degenerative nephritis"—of the tubules of the kidney, and are very commonly first detected at the time of the appearance of the eruption. They are usually of a mild character, and with the fall of temperature, and fading of the rash, may disappear altogether during the second week, so far, at least, as the microscopical evidence of the urine is concerned. In every such case when one finds traces of even a mild degree of catarrhal or degenerative alteration, the possibility of its continuance up to the time of the appearance of a true post-scarlatinal nephritis should not be lost sight of. It is, naturally, impossible to determine how much, or how little damage may have taken place in any individual instance. That we may have, rarely, actual pathological alteration slowly going on, without a trace of albumin, or without the evidence afforded by casts, is definitely established by a number of reported instances. In cases which succumb to the

[318] See Eichhorst (*loc. cit.*, p. 239).

[319] Friedländer (C.): Fortschritte der Med., 1883, vol. i, p. 81.

scarlatinal infection within the first two or three days, more or less marked anatomical alteration in the kidneys is frequently observed; but, as these results are known to often depend on exceptionally grave toxæmia, or some intercurrent complication, it is not possible to draw definite conclusions from them. In the great majority of cases complicated by a post-scarlatinal nephritis, the early catarrhal inflammation, when present, subsides entirely, being followed by a period during which, so far as we can determine by examination of the urine, no active change is taking place. Again, less often, the early inflammatory change may continue throughout the course of the attack, though in a mild form, up to the time when the symptoms of late renal involvement make their appearance.

Septic Nephritis.—In a small number of cases characterized by an overwhelming intoxication by the scarlatinal virus, and associated usually with grave throat symptoms, pseudomembranous inflammation, ulceration, and involvement of the lymphatic glands, there may develop during the first, or early in the second, week a severe nephritis as a direct result of the intensity of the infection, which is commonly in these cases a "mixed one," the streptococcus pyogenes being an added factor in the etiology of the renal inflammation. Not infrequently the symptoms are so masked by the malignancy of the attack, that the existence of a nephritis is not discovered until after death. There is no dropsy, and uræmic symptoms are absent, while the urine, which may show the presence of albumin in greater or less amount, usually without the co-existence of casts or of blood, may, in rare instances, be normal during the entire course of the attack. The condition is one of profound septicæmia, and, although the evidence of renal involvement may be wholly absent, the kidneys reveal marked pathological alteration after death.

Post-scarlatinal Nephritis.—The occurrence of post-scarlatinal nephritis, by which is meant a nephritis developing after the subsidence of the acute symptoms of the disease, varies greatly in different epidemics, only emphasizing in its very uncertainty the peculiar characteristics of the disease or the varying susceptibility of the individual. It has been shown elsewhere that the nephritis developing after the acute stage is by no means always purely glomerular, though, with the advancement of convalescence the frequency of this form, anatomically at least, increases. In Friedländer's series it was present in 18 per cent. Cadet de Gassicourt[320] has noted the occurrence of

[320] See Moizard (*loc. cit.*, p. 148).

a late scarlatinal nephritis in 30 per cent. of all cases. Ashby[321] finds that, taking the average of several years, about 6 per cent. of his hospital patients developed a post-scarlatinal nephritis. Caiger (*loc. cit.*, p. 156), in a series of 2078 cases, gives the frequency of "acute nephritis" as 3.32 per cent. It is manifestly impossible to determine early in the course of the attack whether, in a given case of scarlet fever nephritis may or may not occur, a mild case of the disease being followed, in many instances, by severe renal involvement, while, again, a most severe attack may escape. As a general rule, however, it can be said that, the severer the type of the infection, the greater is the danger of a subsequent nephritis.

The views advanced by some of the older writers[322]—that every case of scarlatina is accompanied by a catarrh of the renal tubules, or that the involvement of the kidneys is but the peculiar localization of the specific poison, an essential "symptom" of the disease—are no longer tenable. The opinion held by the early pathologists, of a reciprocal relationship between the functions of the skin and the kidneys in scarlatina, is interesting. They assigned to the skin the primary rôle in the elimination of the poison circulating in the blood, as shown by the intense efflorescence and abundant desquamation, and held that, if not present, certain renal changes developed from an effort on the part of the kidneys to eliminate the poison, thus giving rise to a nephritis, which, occurring commonly with beginning desquamation, was believed to be essentially a complication of this stage.

The weight of evidence points to the view commonly held to-day, that the occurrence of nephritis during the course of scarlet fever is due to the circulation in the blood of the specific virus, or toxin, which, eliminated by the kidneys, acts as a direct inflammatory irritant in greater or less degree in each individual case. In this connection the view held by von Jürgensen (*loc. cit.*, p. 180), that the effect of the inflammatory irritant depends not only upon its virulence (toxicity), but upon the length of time during which it acts upon a given local site, is extremely interesting and important. In many instances the course of the nephritis is a variable one, improvement in the symptoms alternating with evidences of more serious disturbances. In such cases the conclusion that the specific scarlatinal virus is itself the cause, whether present in the blood in increased amount or in increased toxicity, is certainly suggestive. The early slight inflammatory changes

[321] Ashby and Wright: "Diseases of Children" (New York, 1896), p. 365.
[322] See Thomas (*loc. cit.*, p. 247).

are, according to this view, due to the same local irritation which, under varying conditions, may produce the more pronounced alterations seen later in the course of the disease. That *external conditions* have little or no influence upon the occurrence of nephritis in scarlatina is borne out by the evidence of many observers; and particularly is this true of the influence of cold, or of "catching cold," to which many cases of scarlatinal nephritis were formerly attributed. Mayr (*loc. cit.*, p. 207), writing in 1864, had seen no untoward results from exposure to the severest weather.

Henoch does not share the belief, still held by some, that there is any connection between suppressed perspiration or exposure to cold and the scarlatinal nephritis, almost all his cases having developed in spite of every precaution (*loc. cit.*, p. 587). Unnecessary exposure in any case would, none the less, be ill advised.

Age exerts but little influence upon its occurrence, though it is less common in young adults than in childhood. Males and females are affected about equally up to the age of puberty, after which time there is a slight increase in favor of males. As a rule, the first active indications of scarlatinal nephritis develop late in the first, or early in the second, week, appearing at any time from the twelfth up to the twenty-first day of the attack, exceptionally later.

In a certain percentage of cases there develops at this time a simple albuminuria, which, unassociated with any additional changes in the urine, or with other symptoms, lasts but a few days, and then disappears entirely. Again, it shows a striking variability. Examination of the urine may show the presence of albumin, while later upon the same day, or upon alternate days, it may be absent.

According to Caiger (*loc. cit.*, p. 151), this albuminuria occurs in 4.28 per cent. of all cases of scarlet fever, and is interpreted by him, and by Henoch also, as the mildest expression of the same process seen in the acute scarlatinal nephritis.

The onset of a true post-scarlatinal nephritis may be sudden and abrupt, though, as is more often the case, if careful and repeated examinations of the urine have been made daily, and the amount secreted has been accurately recorded, there will be found a gradual, though marked, diminution in the quantity of urine secreted during the twenty-four hours, together with the presence of a variable amount of albumin, before the appearance of the cloudy, smoky urine and the clinical symptoms characteristic of the acute attack.

Following the subsidence of the initial temperature to normal or

thereabouts, the child, who has seemed apparently well, on the road to convalescence, becomes pale, is restless or irritable, and complains of headache, thirst, and loss of appetite. Constipation may be present, or one or more attacks of vomiting may precede the acute symptoms of renal trouble. The pulse early in the attack is quickened, while later, and especially when complicated by uræmia, it becomes slower and even irregular, and throughout the course of the attack the tension is greatly increased. The temperature may show a slight initial rise of $^1/_2$ to 1 degree, rarely more, which persists for a few days.

The urine becomes scanty, of a smoky tinge, and when allowed to stand deposits a dark reddish-yellow precipitate, while albumin is present in marked degree. Among the earliest evidences of a threatened nephritis many writers lay great stress upon a slight rise of temperature following the normal, considering a rise of even $^1/_2$ degree as of especial significance. The occurrence of œdema, however slight, is an invariable indication of threatened trouble, and yet it may rarely be absent during the entire course of the disease (Henoch). When present, it is usually seen first as a slight puffiness of the eyes, involving particularly the lower eyelids and their immediate neighborhood. It may be present early upon the dorsum of the feet, or upon the knuckles, varying in amount from day to day. In other cases its development is extreme, the entire face becoming swollen and bloated, and the feet and legs œdematous, pitting readily on slight pressure, while the scrotum and penis in the male and the labia majora in females may be involved. In exceptional instances the skin and subcutaneous tissue of the entire body may be tense, swollen, and œdematous, in rare cases the skin being actually tender, owing to its extreme tension, while the eyelids can be opened only with great difficulty.

With the development of the early symptoms of nephritis, as noted above, the examination of the urine is of the greatest importance.

The *amount* of *urine* secreted is much diminished, varying from a few cubic centimetres in extreme cases to 500 cubic centimetres in the twenty-four hours. The *reaction* is usually *acid*, unless altered by drugs. The *specific gravity* ranges from 1.006 to 1.065, the latter being rare, though some of the densest urines met with occur in scarlatinal nephritis.[323] The amount of *urea* is usually under 2 per cent., often little more than 1 per cent. The *albumin* ordinarily varies from 0.05 to 0.1 per cent., reaching 1 per cent. or even higher in severe cases.

[323] Saundby (R.): "Lectures on Renal and Urinary Diseases" (Philadelphia, 1897), p. 101.

The *diazo-reaction* is of no value in scarlet fever; at times it may be present, though more frequently, in the writer's experience, it is absent. *Microscopically*, there may be present hyaline, epithelial, granular, and blood-casts; fragmented renal epithelium; white and red blood-corpuscles, the latter in varying numbers in different instances; uric acid and oxalic acid in crystalline and amorphous form, and more or less granular *débris*.

While the above represents the conditions prevailing in an average case af acute scarlatinal nephritis, there may be striking variations in the urine from day to day, or even a wide variation in the findings as a whole, since it must not be forgotten that nephritis may be present with but little, if any, evidence in the urine.

Cases characterized by a mild degree of pathological alteration in the urine, and associated usually with a moderate amount of œdema, not infrequently begin to improve early in their course, and often, after two or three weeks, the renal symptoms have wholly disappeared; other times the albuminuria may persist indefinitely, following the appearance of the acute stage and rendering the patient liable to a subsequent relapse at any time. In those instances in which the symptoms persist for from six weeks to two months, the condition not infrequently becomes subacute or chronic, and the damage already done may last for years.

Among the added complications which may arise during the course of a nephritis, the occurrence of *uræmia* is of the gravest significance. In rare cases[324] the first indication of the developing nephritis may be an abrupt and sudden uræmic attack. As a rule, however, the evidence of threatened uræmia does not appear until the existence of the nephritis has been for some time recognized, and follows generally a more or less prolonged diminution in the amount of urine secreted, occurring more frequently in the severe cases, though even mild cases are by no means exempt.

The onset of uræmia may be gradual or abrupt. Headache, vomiting, stupor, and the peculiar twitchings of the facial muscles, or those of the hands, so characteristic of the condition, are usually the first indications of the coming attack. The pulse is slow and the temperature may be subnormal. The tongue is dry. Less frequently there is stupor more or less complete from the first, the temperature is elevated, the pulse of small volume and increased, the respirations are short and

[324] See Henoch (*loc. cit.*, p. 597); Leichtenstern: Deutsche med. Woch., 1882, pp. 246 *et seq.*

hurried, and the skin is dry. Convulsions may develop, clonic in character and of varying intensity, involving the face and the extremities as a whole, in sequence, or more rarely picking out scattered groups of muscles. The urine and fæces may be discharged involuntarily. Cyanosis is marked, the pulse becomes slow and irregular, and the temperature falls rapidly. Complete suppression of the urine follows, coma ensues, and in the vast majority of instances characterized by these grave symptoms the case ends fatally.

Rarely, when the patient has survived, attacks of mania, melancholia, aphasia, and amaurosis have been noted as sequelæ.

Of secondary importance only to uræmia is the development of excessive *œdema*, which, acquiring an extreme grade during the course of the nephritis, may be associated with general *anasarca*, or even with the exudation of fluid into the serous cavities of the body. This is seen more commonly as *ascites*, following usually a marked œdema into the skin and subcutaneous connective tissue. Later, exudation into the *pleura* or even into the *pericardium* may take place.

In exceptional instances the sudden development of œdema of the lungs leads to an abrupt and fatal end, while, more rarely, œdema of the larynx is an added complication. The possibility of œdema of the pia mater, and cerebral substance, or cerebral ventricles, is mentioned by Mayr (*loc. cit.*, p. 211).

Heart.—The great susceptibility of the heart, or of the intrinsic cardiac ganglia, to the scarlatinal poison is clearly demonstrated by the pronounced tachycardia—associated with the small, rapid, and even irregular pulse—which is seen early in the attack, often before the appearance of the eruption, more marked in cases characterized by a severe and sudden onset.

Later, in the course of the disease, the heart-sounds may lose their normal tone, the first sound becoming soft and valvular, or they may run together; so that it is impossible to differentiate the two elements. More rarely there may develop later a marked bradycardia; exceptionally actual dilatation may be demonstrated.

That these symptoms are, in many instances, but the expression of a mild myocarditis due to the scarlatinal virus alone seems to have been shown by the careful observations of Romberg.[325] In a small percentage of cases of uncomplicated scarlet fever endocarditis or pericar-

[325] Romberg (Ernst): "Ueber die Erkrankungen des Herzmuskels bei Typhus abdominalis, Scharlach, und Diphtherie." Deutsche Archiv für klin. Med., vol. xlviii, 1891, pp. 369 *et seq.*

ditis also develops, and may or may not be evident from the physical signs. In the majority of cases the endocardium of the heart-wall, rather than of the valves, is involved. When, however, the latter are affected, the mitral segments are the most frequent seats of the lesion.

It has been shown that, following acute scarlatinal nephritis, there is in children, and, to a much less extent, in adults, an almost constant *acute dilatation* and *hypertrophy* of the heart, affecting chiefly the left ventricle. This dilatation and hypertrophy, occurring as a result of the greatly increased vascular tension, which is present early in the course of the nephritis, is associated with more or less marked slowing of the pulse. Clinically, it may be possible to make out this enlargement of the heart only in the severe cases, necessarily characterized by extremely high blood-pressure.

Pericarditis as a sequela of simple scarlatina, though less frequent than in those cases complicated by involvement of the joints, by sepsis or by nephritis, occurs occasionally, and may be associated with serous, or—rarely—purulent, exudate into the pericardium; and in such instances may readily lead to confusion in differentiating between simple dilatation with hypertrophy and the presence of fluid. *Endocarditis* is more often seen following nephritis than in simple scarlatina, though it is probable that, in many instances, murmurs dependent upon a myocardial change are assumed to be of a true endocardial origin. With the occurrence of a septic infection, and the presence of pus-cocci as an added factor, the danger and frequency of subsequent involvement of the heart is greatly increased, any condition from a simple endocarditis to a general *pancarditis* being possible, while, in cases characterized by inflammation of the joints, both *pericarditis* and *endocarditis* may occur, the latter being, under these conditions, a very frequent complication, developing, according to Hodger,[326] in 32 per cent. of all cases.

Lungs. — Apart from the involvement of the upper respiratory tract, noted above (see "Throat"), and the occurrence of œdema of the larynx as a sequela to an intercurrent nephritis, there may develop early in the course of scarlatina, during the first or second week, a mild *bronchitis*, or even a more or less extensive *broncho-pneumonia*, which, not infrequently being masked by the other symptoms present, escapes notice. Henoch (*loc. cit.*, p. 680) holds that this early involvement of the bronchi and lungs is very much more common than we are led to believe.

[326] Hodger: See Eichhorst (*loc. cit.*, p. 241).

Later on, and particularly in those cases with marked involvement of the pharynx, bronchitis and broncho-pneumonia may develop as a result of direct extension of the process in the throat downward. *Broncho-pneumonia* may ensue from the accidental carriage of septic material from the throat into the trachea, bronchi, and lungs (the so-called *Schluck-pneumonie*), or, again, it may be the result of direct infection through the blood-vessels (a part of the general sepsis).

True *acute croupous pneumonia* occurs more frequently in cases complicated by scarlatinal nephritis than in those which run a normal course, while the possibility of acute œdema of the lungs must be remembered. In McCollom's series of ninety-eight fatal cases (*loc. cit.*) fifteen were due to a broncho-pneumonia.

Pleuræ.—As already noted in a certain number of instances, the scarlatinal virus shows a peculiar selective affinity for the serous membranes of the body, and may even in uncomplicated cases, cause inflammation of the pleura, associated either with or without exudation, which, however, when present, almost constantly becomes purulent as a result of a secondary infection. As a rule, in simple scarlet fever this involvement of the pleura is first seen during the second week of the attack, and is commonly unilateral. More rarely, during convalescence, and in cases unassociated with involvement of the joints or other complications, a serous pleurisy may develop, with excessive exudation, which not infrequently ends fatally.

Central Nervous System.—Thomas (*loc. cit.*, p. 275) considers the occurrence of severe cerebral or spinal symptoms the most frequent complication of scarlatina. They develop, as this writer says: "whenever the disease runs a severe course, or there are present other serious complications." If we consider the appearance of marked cerebral or spinal disturbance in every instance as a true complication of the disease rather than as a symptom of the infection, this view must be accepted as correct; but the author quoted admits that it is not always possible in these cases to discriminate between a symptom as such and an actual complication. In almost all severe cases the early cerebral symptoms are marked, severe headache, followed by great languor, dullness, or apathy being present, or, again, convulsions occurring but once, or repeated with varying intensity, marking the onset. Delirium of a mild type—in which the patient, though answering all questions rationally, is confused, and the familiar objects about him become distorted—may occur before the appearance of the eruption, while in other cases delirium with great restlessness is

seen early and persists throughout the course of the febrile stage, assuming all the seriousness of an added complication. In rare cases the early delirium is followed by rapidly developing coma.

Pronounced cerebral symptoms may arise at any time during the course of the disease, though, when occurring early, before the appearance of other complications, they are largely due to the intense toxæmia, and, in a measure also, to the extreme elevation of the temperature. Very frequently, with the fall of the temperature, they disappear entirely, giving way to a quiet and natural sleep, out of which the patient wakens quite himself again. In many instances the extreme cerebral disturbance may be due simply to the prolonged elevation of the temperature.

In that group of cases characterized by other serious complications, with the added danger of sepsis, the symptoms referable to the cerebro-spinal system may be the result of a direct extension of the local process, as from *mastoid disease,* or due to septic emboli with resulting *meningitis* (a rare occurrence); while, with the development of *uræmia*, the appearance of ocular symptoms, such as temporary partial loss of vision (amaurosis), due to arrested papillary reaction, and retinitis, or aphasia and hemiplegia are the result, rather of the intercurrent nephritis, than of the specific scarlatinal virus, and in those cases which recover eventually disappear.

The Eyes.—Though the early catarrhal inflammation of the eyes, so constant an accompaniment of measles, is absent in scarlatina, and local inflammatory processes affecting them, as the direct result of the specific poison, are of the rarest occurrence, various complications may arise during the course of the disease, due to co-existent complications, many of which have been already described. In every severe case, with the greatly diminished secretion of the lacrymal glands and the sluggish action of the eyelids, there is danger of foreign particles lodging upon the cornea, with resulting inflammation, necrosis, and even panophthalmitis.

Early in the attack *photophobia* or a *mild conjunctivitis* may arise from direct extension of the inflammatory process accompanying the eruption in the immediate neighborhood of the eyes, usually following abrasions upon the eyelids themselves.

The *lacrymal duct*, and the *lacrymal gland* as well, may be involved by an extension of the local pharyngeal inflammation and ulceration. *Catarrhal conjunctivitis*, rarely with *diphtheritic inflammation*, may occur. Rarely the following complications may arise:

Keratitis, simple or purulent, with occasional perforation of the cornea; *iritis, choroiditis*, and *panophthalmitis*; *amblyopia* and *amaurosis*; *neuroretinitis* of nephritic origin; *optic neuritis* with meningitis, and *hæmorrhage* into the retina.

Gastro-intestinal Tract.—Occasionally early in the course of the disease, particularly in young children, a more or less severe *stomatitis* occurs, with ulceration of the mucous membrane of the mouth and cheeks, accompanied by increased salivation or even hæmorrhages: frequently a very painful condition, and one which seriously interferes with nutrition. More rarely, actual gangrene, or *noma*, results, with rapid destruction of the tissues of the cheek or tongue.

The early initial *vomiting*, so constant an accompaniment of the onset of the disease, is essentially a symptom of the infection associated with the sudden rise of temperature and the invasion of the system by the specific virus. It is frequently seen later in the course of the attack, associated with the development of nephritis, or with the onset of uræmia, and, clinically, it is impossible to distinguish the vomiting due to reflex disturbance as a result of the disease itself, of nephritis, of uræmia, or as following an aggravated cough, from that due to any one of the rare pathological lesions which are found occasionally post-mortem.

On the part of the intestinal tract a severe *diarrhœa* is frequently an early and prominent symptom, acquiring, in some instances, such an extreme grade as to constitute an actual complication. Litten[327] has classified the inflammations of the intestinal tract in scarlatina into three groups:—

(*A*) Simple catarrhal enteritis. Usually of mild character and short duration.

(*B*) Dysentery, with tenesmus and bloody, purulent stools.

(*C*) The diarrhœas of typhoidal character, with loose, watery movements, associated with marked tympanites, and with great liability to fatal hæmorrhages, and characterized by markedly typhoidal symptoms.

Liver.—Enlargement of the liver sometimes occurs, usually most marked at the time of greatest intensity of the eruption. It may or may not be readily palpable. In severe cases there may be an actual atrophy.

The presence of a mild degree of *icterus* during scarlet fever

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[327] Litten: "Charité Annalen," vol. vii, pp. 128 *et seq.*

is comparatively frequent, many epidemics being peculiarly characterized by the commonness of its occurrence. It is usually of mild grade, and is more pronounced after the disappearance of the eruption, commonly passing away with the establishment of convalescence. Fatal cases are, however, recorded in literature, often associated with acute destructive changes in the liver. According to Baginsky,[328] its development, coincident with or during the existence of a nephritis, is particularly to be dreaded, as predisposing to the danger of uræmia.

Skin.—In addition to those irregular forms of scarlatina, so called from the peculiarity of the eruption, there are seen in a certain number of cases other changes, either local or general, which, differing from the normal, are essentially complications. The occurrence of these conditions, which are commonly the result of a localized or general septic infection, due to the entrance of pus-cocci into the deeper layers of the skin, is very variable. In a few rare cases the *process* of *desquamation* is extreme, involving the deeper layers of the dermis to such an extent that raw and excoriated surfaces follow. Exceptionally the nails may be lost. In severe cases the development of a *decubitus* over those areas exposed to constant pressure is not uncommon. Less frequently a general *furunculosis* or *multiple abscesses* are seen, while rarely *gangrene* may ensue, involving the skin, either locally, or attacking an extremity, or even the genitalia. Among other possible conditions the occurrence of *erysipelas*; *eczema* affecting the face, ears, and head; *urticarial* and *pemphigoid* eruptions has been noted.

Phlebitis.—Moizard and Ulmann[329] have recently described the very rare development of phlebitis, occurring during the course of scarlet fever, in a case under their observation, affecting the right axillary and humeral veins; and have collected from the literature notes of four cases in which phlebitis developed during scarlatina.

A bacteriological examination in this instance proved the phlebitis to be the result of a streptococcic septicæmia. In the four cases cited by them a branch of the right brachio-cephalic, the inferior vena cava, the jugular, the veins of Galen, and the right lateral sinus were involved. In conclusion, they were not able to establish any absolute relationship between the severity of the infection and the

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[328] Baginsky (Adolf): "Die Kinderkrankheiten" (Berlin, 1889), p. 117.

[329] Moizard and Ulmann: "La Phlebite Scarlatineuse." Archives de Méd. des Enfants, vol. ii, No. 10, 1899, p. 601.

occurrence of phlebitis, though, judging from the cases reported, it would appear to be more common in the grave infections. It may take place at any time between the fourth and the fifteenth day.

SEQUELÆ.

Considering under this head those conditions which remain as a temporary or permanent result of the scarlatinal process, it is not surprising that, in a disease which manifests itself with such varying degrees of intensity, affecting, in the severer forms, almost every organ in the body, we may find each individual complication giving rise, not infrequently, to sequelæ of greater or less severity.

As the complications of scarlatina are often but the exaggeration of single symptoms, so, naturally, in many cases, the sequelæ are but the result of aggravated complications. It is an interesting fact that in many instances after recovery from an unusually severe scarlatinal toxæmia, which have been unaccompanied by complications, there is a marked insusceptibility on the part of the individual to other infectious diseases. Exceptions, of course, occur here as elsewhere.

In a certain number of cases recovery may be followed by *anæmia*, more or less persistent, and associated with a slightly delayed return of the physical strength, and some susceptibility to mild affections; rarely recovery is followed by marked *cachexia*. There is a striking contrast between measles and scarlet fever in respect of the absence of any marked predisposition to tuberculosis in the latter disease, following which a latent tubercular infection is not frequently seen. In a small percentage of cases there may develop evidences of a tubercular process in the lungs and lymph-glands, occasionally in the bones or joints, and in rare instances in the meninges.

Among the specific sequelæ of scarlet fever dependent upon individual complications may be included those conditions resulting from excessive involvement of the pharynx, associated with streptococcic infection, or complicated by true diphtheria. Following the severe septic anginas, with extensive inflammation or ulceration, there may remain a *chronic enlargement* of the *tonsils*, or *chronic inflammatory changes* in the *pharyngeal* and *nasal mucous membrane*. Forchheimer[330] has seen persistent *ozæna* as a sequela of a streptococcic angina in scarlet fever. Following a true diphtheritic infection in

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[330] Forchheimer (F.): "Scarlet Fever," in "Twentieth Century Practice of Medicine" (New York, 1898), vol. xiv, p. 80.

scarlatina, one may meet with *paralyses* involving the muscles of accommodation or affecting the soft palate.

The occurrence of *partial* loss of hearing, or of *total deafness*, as a result of otitis media, is of the gravest importance, and, unhappily, one of the commonest sequelæ of the disease. *Chronic suppuration of the middle ear, caries* and *necrosis* of the bony structure of the *tympanum*, involvement of the *mastoid cells*, paralysis of the *facial nerve*, and, rarely, involvement of the *meninges* or *brain* may be the result of a suppurative otitis media.

As the result of an intercurrent acute scarlatinal nephritis, the possibility of a subacute or chronic nephritis must not be lost sight of, though the occurrence of such a chronic nephritis is not common. While the average duration of an ordinary scarlatinal nephritis may be said to extend from four to six weeks, albumin and casts have been present in the urine and œdema of the face has been noted in the tenth week of the nephritis.

Endocarditis, with resulting permanent lesion of the valve-segments, is a not uncommon sequela of scarlatina, affecting usually the mitral leaflets.

In rare cases, as a result of the *scarlatinal synovitis* or *arthritis*, there may remain permanent *deformity* and *stiffness* of one or more of the articulations attacked, the large joints, as a rule, being affected, following a *pyæmia*.

Among the sequelæ depending upon changes in the *skin* the following are occasionally seen: *Torticollis*, the result of cellulitis, and rarely as a sequela to inflammation of the cervical vertebræ; *chronic furunculosis*; intercurrent *chronic skin eruptions*, greatly delayed; and even secondary desquamation.

Among the conditions which may remain as a result of the involvement of the *central nervous system* Fürbringer[331] has noted the occurrence of a localized *hæmorrhagic encephalitis*, and Henoch has seen *aphasia* of almost a year's duration. Moore[332] notes the development of *chorea* at periods varying from two to six months after the attack. Priestly[333] cites 13 cases of chorea following scarlatina, out of 5355 cases under observation: a proportion of 1 in 412. Carslaw[334]

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[331] Fürbringer (P.): "Scarlatina," in Eulenberg's "Real-Encyclopadie," vol. xvii, 1889, p. 478.

[332] Moore (J. W.): "Eruptive and Continued Fevers" (New York, 1892), p. 171.

[333] Priestly (J.): Brit. Med. Jour., September, 1897, p. 805.

[334] Carslaw: See Osler, on "Chorea and Choreiform Affections" (Philadelphia, 1894), p. 17.

gives 3 cases out of 533, while scarlet fever is given as the sole antecedent cause of chorea in 6 per cent. of all cases in the Collective Investigation Committee's Report.[335]

Acute psychosis may develop during convalescence. *Chronic œdema of the glottis* or a gradual *paralysis* of the *vocal cords*, though rare, has been reported. Further rare conditions noted in the literature are choreifom-athetotic movements of a spastic arm, chronic epileptiform conditions, tetany, and traumatic tetanus following surgical scarlatina.[336]

PATHOLOGY.

The gross and histological lesions found post-mortem in scarlet fever depend essentially upon two processes: first, the action of the scarlatinal toxin, associated with the changes seen in any acute febrile disease; and, secondly, they may occur as a result of a mixed infection, due to entrance into the organism of the streptococcus pyogenes, the staphylococcus pyogenes aureus or albus, the pneumococcus, and, rarely, other micro-organisms. So long as the specific agent concerned in the scarlatinal infection remains obscure, it must be impossible—in many instances, at least—to determine, in a given case, which of these two elements is the predominant one. In cases succumbing early in their course to the intensity of the poison, before the development of secondary infections, we must assume the changes present to be due to the specific scarlatinal virus, while in those which prove fatal later, associated with grave throat lesions, streptococcic angina, etc., the possibility of an added etiological element in the lesions present after death must be admitted.

Skin Eruption.—The scarlatinal exanthem so peculiarly characteristic of the disease is not seen after death, except in cases in which the inflammatory process has been unusually intense, when the skin may still retain a slightly reddened appearance; and in the severe hæmorrhagic forms in which there has been an actual exudation of the coloring matter of the blood, with the formation of definite petechiæ.

The process consists essentially in a hyperæmia, followed later by the establishment of desquamation, by an exudation into the rete Malpighii, and by cell-proliferation. Unna,[337] however, does not re-

[335] See Brit. Med. Jour., vol. i, 1887, p. 425.

[336] See Fürbringer (*loc. cit.*, p. 478).

[337] Unna (P. G.): See Orth's "Lehrbuch der Spec. Path. Anatom." (eighth edition, 1894), vol. ii, pp. 629 *et seq.*

gard the process as in any sense an inflammatory one. According to this authority, the following changes occur with the development of the exanthem: There is present at the height of the eruption a marked shrinking of the epidermis, while the blood-vessels of the cutis and papillæ are widely dilated, to which fact he attributes the turgescence of the skin, so often seen at this stage, rather than to the presence of actual œdema. There is further, according to Unna, a striking absence of any true inflammatory exudation of white blood-corpuscles. Toward the end of the eruptive stage, and with beginning desquamation, collections of connective tissue cells are usually seen about the vessels of the papillæ. Plasma-cells are not formed, while mast-cells in any large number are first seen with the establishment of desquamation. The rete Malpighii shows no marked early changes, mitosis occurring first during desquamation. He considers the development of œdema a co-existent condition of neurotoxic origin, and not due to the erythema, regarding the entire process as a vasomotor disturbance, and not a true inflammation.

Von Jürgensen (*loc. cit.*, pp. 114 *et seq.*) agrees with the view held by Unna, considering the occurrence of a true interstitial œdema of the cutis in scarlatina the exception; and further holds that it is impossible to speak of the process as an inflammatory one, assigning the alterations in the skin to the effect of the specific scarlatinal virus, which produces a pure vasomotor paralysis of the peripheral vessels. Thomas (*loc. cit.*, pp. 202 *et seq.*) considers the changes due to a hyperæmia and exudation into the rete Malpighii. Ziegler[338] describes the scarlatinal exanthem under the head of "inflammations of the skin," as being characterized by a more or less extensive cellular exudate into the tissues.

Kaposi[339] holds that the anatomical changes in the skin in the normal forms are due to hyperæmia with moderate exudate, the papillary and vesicular eruptions arising as a result of excessive exudation and cell-proliferation in the papillæ and rete. Pearce,[340] who, in a study of twenty-three fatal cases of scarlatina, has added a most valuable contribution to our knowledge of the pathology of the disease, records the histological lesions in the skin in nine cases. Briefly they are as follow: Early dilatation and congestion of the blood-vessels,

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[338] Ziegler (E.): "Lehrbuch der Spec. Path. Anatom." (Jena, 1895), vol. ii, p. 416.

[339] Kaposi (M.): "Path. und Therapie der Hautkrankheiten" (Berlin and Vienna, 1899), p. 243.

[340] Pearce (R. M.): "Boston City Hospital Reports," X Series, 1899, p. 50.

and slight dilatation of the lymphatics, together with the occasional presence of a few leucocytes and lymphoid cells about the lymphatic vessels beneath the rete; later, from the fifth to the tenth day a marked infiltration of the epithelium with polymorphonuclear leucocytes, which were even found mixed with the desquamating epithelial cells, and, in many instances, with red blood-corpuscles as well. The deeper cells showed occasional mitosis.

It will be seen that this description differs materially from that given by Unna in the marked infiltration and exudation of white blood-corpuscles, as a result of which it is evident that the process may be inflammatory, as well as of vasomotor origin. The minute bright-red points in the exanthem of scarlatina represent small focal areas of intense dilatation and congestion, and, though commonly most marked about the hair follicles, the rash bears no definite relation to them, and may develop equally well over a cicatrix following a burn.[341]

Desquamation.—Following the disappearance of the exanthem the superficial layers of the epidermis are lost, desquamation being established early, as a rule, over those areas where the eruption was first seen. As already noted, it is most extensive where this process has been intense, occurring as a direct result of trophic changes in the cells of the epidermis, induced by the action of the specific poison and the local inflammatory reaction. Rarely these changes may involve other allied structures as well. The nails of the fingers and toes may drop off, or the hair may fall out, or even warts may drop off as a consequence of scarlet fever.[342]

According to Unna, every alteration occurring in the skin in the course of the disease is the result of the direct action of the specific scarlatinal virus.

Mucous Membranes of the Pharynx and Nose.—The changes here are essentially those seen in the skin—dilatation and congestion of the blood-vessels and lymphatics, with, later, a leucocytic infiltration.

Tongue.—In eight cases examined by Pearce (*loc. cit.*) the process in the tongue was found to be similar to that in the skin, but beginning earlier and being very much more pronounced, with marked involvement of the papillæ: two points which agree with clinical experience.

Lymphatic System.—The only really constant gross lesion in scarlatina is an hyperplasia affecting all the lymphoid structures of the

[341] See Thomas (*loc. cit.*, p. 212).
[342] See Moore (*loc. cit.*, p. 173).

body. Clinically, this is seen in the enlargement of all the superficial lymphatic glands, most marked, as already noted, in the maxillary and submaxillary glands, which not infrequently undergo suppuration and break down; and in the enlargement of the spleen, which occasionally acquires an extreme size. After death in addition a pronounced hyperplasia of all the lymphoid elements of the tissues, including the single and agminated glands of the intestinal tract, is usually found. Histologically the lesions have been described by Klein[343] and by Pearce (*loc. cit.*). According to the latter observer, the changes are not constant in all cases. In the *lymph-nodes* there is congestion of the blood-vessels, together with dilatation of the lymph-sinuses, which contain large endothelial cells. These latter are frequently phagocytic, containing lymphoid cells, red blood-corpuscles, and, less commonly, polymorphonuclear leucocytes. The *lymph-nodules* are enlarged, with pale centres, due to the presence of large numbers of endothelial cells.

Spleen.—The spleen may be normal in size or greatly enlarged. The histological changes consist essentially in an hyperplasia of the splenic pulp together with infiltration of plasma-cells, enlargement of the Malpighian bodies, and congestion of the blood-vessels. Focal lesions, either inflammatory or hæmorrhagic, may be present.

Heart.—The pathological changes found in the heart following scarlet fever may arise as a result of the scarlatinal toxin alone, or may be due to the occurrence of a mixed infection with the presence of streptococci or staphylococci in the circulating blood. Clinically, the early evidence of the action of the scarlatinal virus upon the heart is seen in the occurrence of acute dilatation, which not infrequently develops with unusual rapidity, being associated with certain transitory murmurs, while, in case of nephritis, it has been shown that the danger of subsequent anatomical change in the heart is markedly increased. Steffen[344] considers the oncome of *acute dilatation* under these circumstances of the gravest significance. It may, according to this observer, take place so rapidly that the apex-beat is found in the anterior axillary line within twenty-four to forty-eight hours. As a natural result, dilatation of the left side of the heart follows, while the right side may also be involved in a slight degree. It has further been shown by Silberman[345] that, following this dilatation, an *acute hypertrophy* of

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[343] Klein (E.): "Trans. Path. Society" (London, 1877).

[344] Steffen (A.): "Ueber einige Wichtige Krankheiten des Kindlichen Alters" (Tübingen, 1895), p. 211.

[345] Silberman (O.): "Jahrb. f. Kinderh.," vol. xvii, p. 178.

the left ventricle may ensue, while Romberg (*loc. cit.*) has demonstrated the occurrence of an *acute myocarditis* involving not only the muscle-fibres of the heart, but the interstitial tissue also: a fact of great clinical, as well as pathological, significance.

Pericarditis may be present as a result of the direct extension of the inflammatory process from the inner layer of the pericardial sac, when not infrequently, as shown by Romberg, there is but slight gross evidence of inflammatory change. Otherwise it may follow primary involvement of the pericardium, which shares in the susceptibility of the serous membranes. Occasionally exudation occurs in the simple forms. When due to the existence of a mixed infection of streptococcic or staphylococcic origin, it is frequently associated with more or less exudation of serum and fibrin formation. Less commonly the exudation of fluid into the pericardial sac reaches an extreme degree. Purulent and hæmorrhagic effusions are rare.

Endocarditis is a not uncommon result of the scarlatinal infection, the inflammatory process attacking the endocardial lining of the cavity of the heart, leaving the valves free; or it may involve the valvular segments, giving rise to a simple thickening at the site of the lesion, usually situated at the margin of the valves. Less frequently a true endocarditis verrucosa may follow the simple process. Although it is possible that endocarditis may occur as a result of the scarlatinal toxin, as seems to have been true in the cases studied by Romberg, it is far more frequently due to the existence of a mixed infection, following the direct action of the micro-organisms circulating in the blood, or even of the toxins elaborated by them. In many instances a true *pancarditis* may be present, the endocardium, myocardium, and pericardium as well being more or less involved in the inflammatory process.

Kidneys.—The subject of the pathological lesions of the kidney following scarlet fever has been involved in much discussion. Many observers have asserted that the changes resulting from the scarlatinal poison are confined essentially to the parenchyma; others have found changes in the interstitial tissue alone; and still a third group have described mixed forms of nephritis.[346]

Friedländer (*loc. cit.*), writing in 1883, said: "Whoever attempts to glean from the voluminous literature of the subject the various alterations which may occur in the kidney as a result of the scarlatinal

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[346] For critical summary of literature see Pearce (*loc. cit.*).

process soon learns that it is extremely difficult to find one's way, in the confusion of assertions and theories which often contradict each other."

By many writers that form of nephritis peculiarly characteristic of the scarlatinal kidney is still described as essentially glomerular. Klebs,[347] in 1876, described the frequent occurrence of an acute interstitial nephritis early in the course of the disease, and first called attention to the existence of a glomerular nephritis which developed during convalescence. Klein, in 1877 (*loc. cit.*, p. 430), found definite glomerular nephritis in 23 cases of scarlet fever, which were fatal at periods ranging from the second day to the seventh week. Wagner,[348] in 1880, said he had not seen a pure glomerular nephritis following scarlatina. Friedländer, in 1883 (*loc. cit.*), as a result of 229 necropsies in fatal cases of scarlet fever, classified the pathological lesions of the kidneys as follows:—

1. *Initial Catarrhal Nephritis (the Early Form occurring Coincidently with or Immediately following the Eruption).*—Anatomically the kidneys are moderately hyperæmic, the glomeruli appearing as small, red points. There is usually no marked cloudiness of the cortical substance. Histologically, cloudy swelling of the tubular epithelium is seen, while the glomerular tufts are normal. The capsular epithelium is slightly thickened. Occasionally a small amount of albuminous exudate between the capsule and glomerulus is present.

2. *The Large, Pale, Hæmorrhagic Kidney (Interstitial Nephritis; Septic Nephritis).*—This condition may develop in the first, as well as in the third and fourth, week of the attack. According to this observer, it is rare, occurring in but 12 of his cases. The kidneys are large and pale, with grayish-red cortex. The glomeruli are commonly not visible. Usually large numbers of small, punctate hæmorrhages are present. Histologically there is a marked infiltration of the interstitial tissue, with small, round cells. Commonly but slight alteration of the epithelial cells is noted. This form is found usually in association with severe diphtheritic affections of the throat, phlegmon of the neck, etc., and also in severe septic scarlatinal nephritis with small foci of bacteria in the tissues of the kidney.

3. *The Glomerulonephritis (Post-scarlatinal Nephritis).* — This is considered by Friedländer the most important and typical form, and

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[347] Klebs (E.): "Handbuch Path. Anatom." (Berlin, 1876), vol. i, p. 632.
[348] Wagner (E.): Deutsche Archiv f. klin. Med., 1880, vol. xxv, pp. 529 *et seq.*

as almost characteristic of scarlatina. It occurred in 42 cases of his series, death being due, in the majority of these, to a pure glomerular nephritis alone. Anatomically, the kidneys are hyperæmic, their consistency is increased, and the glomeruli appear as small, grayish points, slightly larger than normal. Histologically, the changes are confined to the glomeruli, which contain little or no blood; they are enlarged and show a marked increase of nuclei. The glomerular loops are converted into a solid mass, and the capsular epithelium is usually slightly thickened. The interstitial tissue appears normal.

Councilman,[349] in a recent monograph upon acute and subacute nephritis, says: "With slight differences in the intensity of the lesions due to conditions which we do not understand, and which may represent increased or diminished local resistance, all susceptible tissues will be affected." He further remarks that, in all serious lesions of the kidney, we find that in one case the glomeruli are principally involved, while in other cases, again, there are lesions of the connective tissue, consisting of active cell-proliferation. The glomerular lesions may be accompanied by degenerative changes in the tubular epithelium, which may be, in part or wholly, secondary to the lesions in the glomeruli. On the other hand, hyperplasia of the connective tissue, though often accompanied by degenerative changes in the epithelium, cannot be considered secondary to such changes.

Based upon a purely anatomical classification, in which mixed forms often occur, he describes, under the head of acute diffuse nephritis, the following forms:—

1. Acute degenerative nephritis, occurring chiefly in infectious diseases.

2. Acute glomerular nephritis, occurring in infectious diseases, notably in acute endocarditis, *measles*, and diphtheria.

3. Acute hæmorrhagic nephritis.

4. Acute interstitial non-suppurative nephritis, occurring notably in diphtheria and *scarlet fever*. Macroscopically, the kidney is large, pale, and mottled. On section it appears moist and opaque, and the markings are obscure. Histologically, the essential lesion consists in acute proliferation of the cells in the intertubular tissue, the proliferation taking place chiefly from the vascular endothelium. The cells lie within and without the vessels, and are present chiefly in the intermediate zone of the kidney between the pyramids and cortex. There

[349] Councilman (W. T.): Boston City Hospital Reports, VIII Series, 1897, pp. 38 *et seq.*

is more or less degeneration and necrosis of the tubules. Leucocytes in small numbers may be present. The glomeruli are not affected.

Three such cases (Nos. 1, 2, and 6) of pure interstitial nephritis following scarlatina with no glomerular changes are further described by Councilman (*loc. cit.*), while in one case (No. 21), an adult kidney from a scarlet-fever patient, the glomeruli were increased in size, the capsules dilated and filled with epithelial cells, and the cells in the glomeruli increased in number. There was no increase of connective tissue, nor any proliferation of the interstitial cells.

Out of twenty-three cases examined by Pearce (*loc. cit.*) he found acute degenerative changes in all. In no case were there any glomerular changes, an *acute interstitial nephritis* being the important lesion. In five cases it was present in a slight degree, while in four which were fatal on the eighth, ninth, fourteenth, and fifteenth days, respectively, the interstitial changes were pronounced. As a result of these studies by Councilman and Pearce it is difficult to avoid the conclusion that an *acute interstitial nephritis* is the most important early renal lesion of scarlatina.

The occurrence of a true glomerular nephritis remains, however, none the less a characteristic lesion of the disease. It is found more commonly late in the course of the attack, after the establishment of convalescence: the result, it may be, of a peculiar susceptibility on the part of the glomeruli, or of an unusual degree of virulence of the scarlatinal toxin, or its prolonged action.

Macroscopically, the appearance of the kidney varies. It is usually increased in size, the capsule strips off easily, in the acute form; the surface is congested and mottled, and minute hæmorrhages may be seen. On section the cortex is pale and the markings obscure, the glomeruli being clearly defined, enlarged, and appearing as small, grayish or pale-yellowish points; occasionally they are reddish brown in color. The pyramids are congested. Histologically, the essential lesions are found in the glomeruli, consisting of acute proliferation of the vascular endothelium, hyaline and fibrinous thrombosis of the vessels, and hyaline degeneration of the vessel-wall. The cells of the capsular epithelium and its supporting connective tissue may proliferate, the capsules becoming so filled with proliferated cells that they are functionally useless. The glomerular lesion is accompanied by degeneration and necrosis in the tubular epithelium. The tubules may become filled with desquamated epithelium, and hæmorrhages may occur into their lumen.

Briefly we may summarize the changes occurring during the scarlatinal process as follows: Early *acute degenerative nephritis* with cloudy swelling; hyaline and fatty degeneration of the epithelium, which undergoes desquamation, the changes being purely degenerative; followed by *acute interstitial nephritis*, characterized by a proliferation of the cells between the tubules, with no glomerular changes. Rarely a true *parenchymatous nephritis* (*acute glomerular nephritis*), characterized by changes in the glomeruli, may be present at this time, usually without evidence of any proliferation of the intertubular cells; while later, after the establishment of convalescence, we may find a pure *glomerulonephritis*, or even changes due to an *interstitial*, as well as a *parenchymatous, nephritis*.

Liver.—In addition to the changes occurring in all acute febrile diseases, Pearce (*loc. cit.*) has described certain focal lesions in the liver, which were present in four out of twenty-two cases, consisting essentially of small areas of necrotic liver-cells with phagocytic cells in their capillaries, and cellular inclusions by the endothelial cells lining the capillaries. Where the necrosis is marked, many of the hepatic cells show infiltration with polymorphonuclear leucocytes. There is no marked reaction about these areas.

Gastro-intestinal Tract. — Stomach. — Fenwick[350] demonstrated that the changes occurring in the mucous membrane of the stomach were not only closely analogous to those seen in the mucous membranes elsewhere in scarlet fever, but that the epithelium of the gastric mucosa took part in the general process of desquamation. Pearce (*loc. cit.*), in a case fatal on the second day, found the surface of the stomach covered with a thick layer of mucus and necrotic epithelial cells, with marked infiltration of polymorphonuclear leucocytes; irregular masses of bacteria—cocci—were also present. The lymph-nodules in the lower part of the mucous membrane were enlarged. Plasma-cells were present in great numbers between the gastric tubules. Three cases dying at varying periods before the fifteenth day showed the same changes, though in less marked degree.

Intestine.—Both the small and large bowel show enlargement and prominence of the single lymph-follicles and Peyer's patches, which share in the hyperplasia of all the lymphoid tissue. There may be present, in addition, changes closely similar to those found in the stomach.

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[350] Fenwick (S.): "Medico-Chir. Trans." (London, 1862), xlvii, p. 209.

Peritoneum and Serous Membranes.—Rarely the peritoneum may be involved, sharing in the general susceptibility of the serous membranes; or any one of the large serous cavities may become the seat of an exudation of fluid, ascites, etc. The inflammatory process differs in no way from that seen under other circumstances. The frequency with which the inflammatory pleural exudate becomes purulent has been noted.

Bone-marrow. — In eleven cases in which the bone-marrow was studied by Pearce (*loc. cit.*) it was found very rich in cells, this being most marked in those cases fatal at two and three years of age. Giant cells, nucleated red blood-corpuscles, and eosinophilic cells were very numerous; lymphoid cells, neutrophilic leucocytes, and abundant cells closely resembling the plasma-cell, making up the cellular elements.

Blood.—The changes in the blood in scarlatina are essentially as follows: There is a reduction in the hæmoglobin, varying with the character and severity of the infection. The specific gravity is usually slightly reduced, while the red blood-corpuscles may show a decided diminution in numbers, being in some instances reduced to 3,000,000 per cubic centimetre. The white blood-corpuscles show a constant increase, differing, in this respect, from measles, in which there is no leucocytosis. Van den Berg,[351] in a study of twelve cases of scarlatina, found leucocytosis in all, which began early and reached its maximum by the fourth or sixth day, persisting, on an average, twenty to thirty days, unless the course of the disease was unusually mild. If interrupted by some complication, it was prolonged beyond this period. He could determine no relationship between the exanthem and the leucocytosis, nor was it affected by beginning desquamation. The leucocytosis consists chiefly in an increase of the adult forms, and is characterized by the persistence of eosinophiles. Sevestre,[352] however, in a study of the blood in scarlatina, says: "A close relationship has been found to exist between the leucocytosis and the rash; the former varies with the severity of the latter, and with the fading of the same; the leucocytosis shows a marked diminution in numbers." According to Kotschetkoff,[353] the disappearance of eosinophiles is a bad prognostic sign, except at the beginning of the fever. They are increased in the mild, but absent usually in the severe, cases.

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[351] Van den Berg (J. B. A. M.): Archiv für Kinderh., 1898, vol. xxv, pp. 321 *et seq.* (Which see for complete references to the literature.)

[352] Sevestre (R.): "Saint Bartholomew Hospital Reports," 1896, vol. xxxii, p. 222.

[353] See Cabot (R. C.): "Clinical Examination of the Blood" (New York, 1897), p. 177.

ETIOLOGY.

Bacteriology.—The specific cause of scarlet fever, as of all the acute exanthemata, remains undiscovered. Notwithstanding the immense amount of work done by scientific investigators, it has been impossible, up to the present time, to isolate, from an individual ill with scarlet fever, that single element which, when introduced into an animal, will reproduce the disease as we see it in man. By several early experimenters (Miquel, Williams, Stoll[354]) children have been successfully inoculated with the disease by means of the serum contained in the vesicles developing in the course of the fever, by the blood, or through the introduction of the epidermic scales beneath the healthy skin.

While these observations are extremely interesting and valuable, as confirming our views of the contagiousness of scarlet fever, they have no direct bearing upon the specific virus, except in so far as we now know, that it may be carried in this way from one individual to another. The belief that the poison of scarlet fever is a contagium vivum must be accepted, and though its exact identity is still a mystery, the drift of all our evidence points strongly to its bacteriological origin, and it is along these lines that we may hope ultimately to find the solution of this perplexing problem. The many forms of bacteria which have been described as causally related to this disease from the time of Hallier (1869)[355] to the present day have failed to stand the test of science, or even in many instances to be confirmed by other observers.

The tendency of later investigations has been rather to attempt to establish the identity of the particular streptococcus so commonly associated with the lesions of the throat and the many complications of the disease as the specific agent.

In 1885 Klein,[356] investigating the epidemic of scarlet fever prevailing in London (Marylebone), held that the source of infection was derived from the milk-supply from a dairy-farm at Hendon, where the cows were then suffering from a constitutional disease associated with enlargement of the udders, together with the development of vesicles upon them. As a result of his experiments made with the streptococcus obtained from these vesicles, he considered this disease to have been true bovine scarlatina. This opinion, however, has not been held or

[354] See Thomas (*loc. cit.*, p. 162).
[355] Hallier (E.): "Jahrb. f. Kinderh., N. F.," ii, 1868-69.
[356] Klein (E.): "Report of Local Government Board" (London, 1885-86), xv.

confirmed by all subsequent observers. Crookshank,[357] in a similar epidemic among cows in Wiltshire, records that, of three hundred consumers of the milk from these cows, not one had scarlet fever. He believed that the disease in question was cow-pox.

Edington, in 1887,[358] isolated from the scales and the blood of patients ill with scarlet fever a bacillus which, when inoculated into rabbits, produced a reaction, associated with a slight rise of temperature, an erythematous rash, and desquamation; but a committee appointed by the Medico-Chirurgical Society of Edinburgh was unable later to confirm these experiments. Though they found Edington's bacillus in three out of ten cases of scarlatina, the inoculations into animals were negative.

Fiessinger,[359] in 1893, formulated a more definite hypothesis of the rôle of the streptococcus in scarlet fever, and considers it to be the infecting agent in the disease.

Dowson,[360] in the same year, affirmed that the scarlatinal virus was a micro-organismal poison which was elaborated in the affected tonsils. This opinion is in accord with the view held by Lemoine,[361] that the throat is very largely the point of entrance of the disease, and assigning to the streptococcus a certain etiological relationship with the affection.

More recently Class[362] has described a diplococcus, which he believes is the primary etiological element in scarlatina. This organism is a non-capsulated diplococcus, appearing occasionally, though rarely, in streptococcic form; polymorphous in character, attaining not uncommonly under certain conditions an unusual size. It is, according to this observer, constantly present in the pharynx in the scarlatinal angina; less commonly it may be cultivated from the skin; and on the first day of the disease, rarely later, from the blood. Control experiments showed the same organism present in 8 out of 36 cultures from the normal pharynx, and in 3 out of 23 from the skin.

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[357] Crookshank (E. M.): The Lancet, 1887, vol. i, p. 1274.

[358] Jamieson and Edington: Brit. Med. Jour., 1887, vol. i, p. 1262-66. See also Edington: Brit. Med. Jour., 1887, vol. ii, p. 394.

[359] Fiessinger: Semaine Méd., July, 1893.

[360] Dowson (W.): Med. Chron. (Manchester), 1893-4, xix, 217.

[361] Lemoine (G. H.): Bull. et Mém. Soc. Med. des Hôp. des Paris, 1895 and 1896. See Gaz. des Hôp. de Paris, November 25, 1895, p. 1337.

[362] Class (W. J.): New York Med. Record, September, 1899, p. 330 (original note). See also Jour. Amer. Med. Assoc., vol. xxxiv, No. 34, 1900, pp. 476-78, and also Jour. Amer. Med. Assoc., vol. xxxiv, No. 13, 1900, pp. 799 *et seq.*

He has further produced, by intravenous injection of cultures of this organism into white swine, a reaction which, if not identical with scarlet fever as seen in man, resembles closely the normal course of a scarlatinal infection.

A number of other investigators, working under similar conditions, have found a diplococcus apparently identical with the above organism.

Baginsky and Sommerfield[363] have described the constant occurrence, in the pharynx and blood in scarlatina, of an organism appearing as a strepto-diplococcus, the etiological relationship of which to scarlet fever they consider extremely suggestive.

In this connection it is interesting to note that, judging solely from the description given, the organism described by them resembles in many ways the diplococcus first described by Class.

Though it is as yet too early to assert positively the exact relationship of these organisms to the disease, we may soon be forced to modify the statements made above, and to accept the etiological element as settled beyond dispute.

Climate.—What influence climate may exert upon the poison of scarlet fever it is impossible to determine. The fact that certain countries enjoy an apparent immunity against the disease may be referable to climatic conditions, or, on the other hand, may be due to a peculiar insusceptibility on the part of the inhabitants. It remains a fact that the disease is more or less prevalent in an epidemic form throughout the temperate zones, while in the tropical and subtropical countries its presence in epidemic form is almost unknown. Japan enjoys freedom from scarlet fever, and in India the disease does not prevail epidemically among the native races. In North America scarlatina is much less common throughout our Southern States and southern California, than in the Northern States; while in South America and in Europe localities with apparently the same climatic conditions as in our exempted territority do not escape repeated outbreaks of the disease.

The influence of the season of the year upon the occurrence of scarlet fever is more evident. From the records of 435 epidemics collected by Hirsch[364] he found that in a given hundred epidemics:—

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[363] Baginsky and Sommerfield: Berliner klin. Woch., No. 22, 1900, pp. 588 *et seq.*

[364] Hirsch (A.): "Jahrsb. ueber die Leistung. u. Fortschrit. in der Gesammt. Med." (Virchow-Hirsch). Vi Jahrg., vol. xvii, p. 131.

29.5	per cent.	occurred	during	the	fall months.
24.7	"	"	"	"	winter "
21.8	"	"	"	"	spring "
24.0	"	"	"	"	summer "

Johannessen[365] has classified the 8608 deaths from scarlet fever, which occurred in Norway between the years 1867 to 1878, as follows:—

24.1	per cent.	occurred	during	the	fall months	(Sept., Oct., and Nov.).
31.2	"	"	"	"	winter "	(Dec., Jan., and Feb.).
24.7	"	"	"	"	spring "	(March, April, and May).
19.8	"	"	"	"	summer "	(June, July, and August).

The mortality during the single years of this period varied between 220 and 1760 deaths, clearly demonstrating a distinct, even though slight, influence of the season of the year upon the mortality and prevalence of the disease. The percentage of mortality increased gradually until the maximum was reached during the winter and early spring months, and fell to its minimum during the summer months.

In England the prevalence of scarlet fever increases slowly from May until September, when there is a rapid extension, which reaches its maximum in October and November, after which there is a gradual decline until the minimum is reached in March and April. The statistics taken from Hirsch illustrate this well. The deaths from scarlatina occurring in London between 1838 and 1853 were 55,287 and gave the following percentages according to the season of the year:—

The	deaths	occurring	during	the	fall months	were	32.1	per	cent.
"	"	"	"	"	winter "	"	22.8	"	"
"	"	"	"	"	spring "	"	19.9	"	"
"	"	"	"	"	summer "	"	25.2	"	"

In America, epidemics are more common in the fall and winter months than in the summer, and the cases which occur in winter have a tendency to prove more severe than those during the milder seasons.

This apparent relationship between the prevalence of the disease and the season of the year suggests strongly the influence of climatic changes, of temperature, or of moisture in the atmosphere, upon the development of the poison, but all attempts to establish any such relationship upon scientific grounds have utterly failed.

Whatever may be the nature of the scarlatinal virus, the occurrence of scarlet fever depends absolutely upon exposure to the specific

[365] *Op cit.*, p. 87.

poison, either directly or indirectly. In a great number of cases the spread of the disease can be traced to direct contagion, while in a very considerable number its origin can be explained only by indirect transmission, and in many instances it is impossible to determine the source from which the poison was derived.

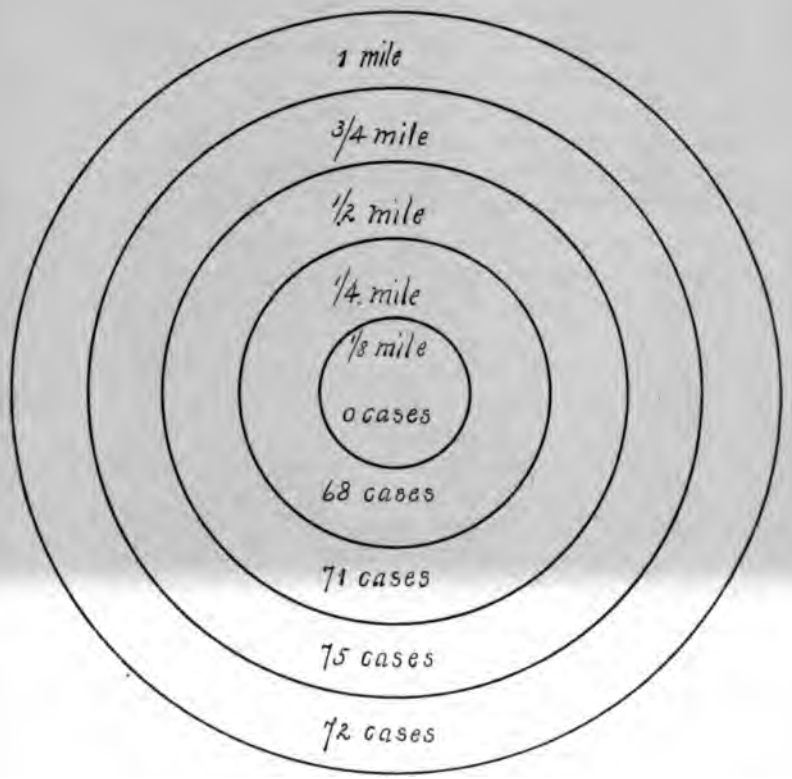
That the poison of scarlet fever is less volatile than that of measles has long been established, and, while of great tenacity, it is not transmitted any great distance through the atmosphere. In those instances in which infection has followed direct exposure to the disease, the contact with the patient is usually an intimate one, though this is not always the case. Our lack of knowledge of the specific virus of scarlatina makes it impossible to determine in what part of the human organism the contagious element chiefly abounds. That it is present in the local lesions of the pharynx, in the discharge from any mucous cavity,—as in an otorrhœa,—in the normal excretions, and that it may in certain instances be transmitted by means of the epidermic scales we are certain; and that it is carried throughout the body by the circulating blood seems equally well established.

The question as to whether the poison circulating in the blood is capable of giving rise to an intra-uterine infection is one which has long aroused great interest, and, could we but prove the occurrence of infection during gestation, there would be no doubt as to this possibility.

Unfortunately, however, it is extremely difficult to do this, and the cases cited in literature of congenital scarlatina do not always exclude some other source of infection immediately succeeding birth.

Thomas[366] remarks that, owing to the fact that most children are born with a scarlet or a yellowish-red tint of the skin, and very soon go through a normal desquamation, it is difficult to decide whether they were born with scarlet fever or not. But, inasmuch as we have undoubted evidence of the transmission of small-pox during intra-uterine life, can we not assume that the same may hold true of scarlatina? On the other hand, we know that mothers, ill with scarlet fever, have given birth to children who have remained free from the infection.[367] A case is cited by Tortual[368] which he considers to have been one of scarlatina contracted during gestation, as follows: A woman, thirty years old, who had never had scarlet fever, nursed her

[366] *Op. cit.*, p. 181.
[367] See Murchison (*loc. cit.*).
[368] See Thomas (*loc. cit.*, p. 182).



Within one mile of the hospital	286 cases.
Cases reported more than one mile from the hospital	757 cases.
Total	1043 cases.

Diagram showing the Influence of the Scarlet-Fever Hospital in Distributing the Disease. (From "Medical and Surgical Reports of the Boston City Hospital," 1897, page 7.)

Thus it will be seen that no cases of scarlet fever occurred within an eighth of a mile of the hospital, and only 286 cases within the mile radius, while beyond this 757 cases were reported. The influence of the hospital in spreading the disease must therefore be considered *nil*.

husband and son, ill with the disease, until shortly before her confinement, and was delivered of a boy on the 19th of September, 1823. The child could not swallow, and had an unusual redness of the skin, which was regarded as a typical scarlatinal eruption. The mucous membrane of the mouth and the tongue was also intensely reddened. The difficulty of deglutition lasted until the fifth day; on the ninth day abundant desquamation commenced,—as is the case in older children,—and later a separation of the nails of the fingers and toes took place, the child ultimately recovering.

Lemoine,[369] in support of his theory that the local lesions in the pharynx contain very largely the contagious element, considers that the contagion of the skin is derived, in a great measure, from the secretions of the throat and pharynx, which have dried upon it. In cases of scarlet fever, in which the pharynx is markedly involved, this is a reasonable assumption, but in instances with, at most, only a mild angina it is difficult to thus explain the origin of the contagion. In cases of infection which occur as a result of exposure to the disease in the earliest stages, before the lesions in the pharynx are marked, some other potent source of the poison must undoubtedly be admitted. In this connection von Jürgensen says: "We teach, and the teaching seems well grounded, that it is only the dried and finely powdered particles of dust which can be scattered throughout the atmosphere. The poison of scarlet fever has a bodily entity, it is not a gas. How, then, can it escape from the moist cavity of the mouth of the patient, and spread in this way through the air?" Bacteriology has established the fact that micro-organisms are not swept from a moist surface by moderate currents of air, and in scarlet fever, as in any other condition involving the pharynx, it must be chiefly through the somewhat explosive efforts of coughing, and the mechanical results of vomiting, that the contagion from the throat is scattered about the immediate neighborhood of the patient, upon the skin, clothes, etc.

Just as it is impossible to determine where in the human body the poison of scarlet fever is elaborated, and from what source it is largely derived, so is it equally beyond our power to say definitely by what channel it is taken up and absorbed. Most theories advanced are at the best mere conjecture. Until we have more definite knowledge of the nature of the specific virus we can only assume that, under certain conditions, the poison may gain access through the respiratory tract,

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[369] *Loc. cit.*

that it may be taken in through the gastro-intestinal tract, or may be absorbed through some break in the continuity of either skin or mucous membrane. Hall,[370] in a very interesting recent article, found, after an extensive review of the literature, that, "while scarlet fever occurs in epidemic form in those countries where cows' milk forms a staple article of food, especially among children, it does not occur in countries where cows' milk is not used as a food, or where children are raised on mothers' milk only." This is true of Japan, where cows' milk is not used and domestic animals are scarce, and it is true in India, also, where, though cows' milk is used, the children are nursed by their mothers until they are three or four or even six years of age.

While this immunity from scarlet fever, together with the absence of cows' milk as an article of food, may be simply a coincidence otherwise explainable, does it not suggest the possibility of infection through the gastro-intestinal tract as perhaps the chief source?

The contagion of scarlet fever may be transmitted by healthy individuals as well as inanimate objects, such as books, clothes, toys, letters, etc. It is also held that, in some instances, animals, such as dogs and cats, may be the carriers of the poison, though whether they themselves become infected with a true scarlatina remains an open question. Those instances reported in literature, of exanthemata in animals, associated with fever and desquamation, cannot be accepted as typical of scarlet fever unless the specific infective agent be isolated and found to fill the conditions required by bacteriology. The fact that the poison of scarlet fever is less volatile than in the case of the other acute exanthemata is well illustrated by the proof constantly afforded in the outbreaks of the disease in children's hospitals, or private houses, where, if the patient be promptly isolated, infection occurs only in those exposed before isolation has been established. A rigid quarantine will prevent further spread with far greater certainty than is the case in small-pox or measles.

The case cited by Forchheimer (*loc. cit.*, p. 15), in which children in one house talked through the open windows to other children, ill or convalescent from scarlet fever, in the next house at a distance of only nine feet and did not contract the disease, is a further proof of the limited diffusion of the contagion about the immediate neighborhood of the patient.

As an example of the means by which the contagion may be trans-

[370] Hall (H. O.): New York Med. Record, November 11, 1899, p. 698.

mitted, the instance cited by von Hildebrand,[371] in which a coat, that had been exposed to the infection a year and a half before, was the cause of a fresh outbreak, is well verified. The case cited by W. Boeck[372] illustrates not only the means of conveyance of the disease, but the great tenacity of the poison as well. Some children were given permission to play with the various articles put away in an old writing-desk. In one of the drawers of this desk were the locks of hair that had been taken twenty years before from two children who had died of scarlet fever, and which had not been disturbed since that time. The children found these locks of hair, took them out and examined them, and subsequently developed scarlet fever. In this instance the proof was as conclusive as it could possibly be; for these were the first cases of scarlatina in the city. In a further series of cases quoted by Thomas[373] the following articles were considered to have been the means by which the contagion was transferred: a letter, a shawl, a box of toys, the cushions of a rocking-chair, and a violin. Even, in one case, a piano is said to have harbored the poison. The danger of a spread of the infection through the linen and bedding of a patient is a real one, and often necessitates, in addition to the careful disinfection of the linen, a separation of the linen of scarlatinal patients in a hospital from that used in the general wards. Instances in which a healthy individual has carried the contagion are many, occurring not infrequently through the agency of those in attendance on the patient. The case reported by Dr. Loeb,[374] of Worms, in which his little girl contracted scarlatina, is a most convincing proof.

Dr. von Essingen went from Worms to Mannheim, visiting, while there, three children ill with scarlet fever. He returned to Worms, and on the afternoon of the same day, while paying a friendly call at the house of his friend Dr. Loeb, took the latter's little daughter upon his lap, holding her for some time. On the following day she developed a typical attack of scarlatina. Dr. von Essingen had not, it seems, changed his clothes between the visit paid in Mannheim and the call in Worms. There was, previous to this, so far as could be ascertained, no scarlet fever in Worms.

An instance in which two individuals, who remained well, were the

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[371] See von Jürgensen (*loc. cit.*, p. 35).
[372] See Johannessen (*loc. cit.*, pp. 162 and 163).
[373] Thomas (*loc. cit.*, p. 164).
[374] Loeb (M.): "Jahrb. f. Kinderheil., N. F.," vol. ix, p. 174.

carriers of the contagion is cited by Allbutt,[375] and is, so far as we have been able to find in literature, the only example of such an occurrence.

"A father, staying in the house of a friend, met, on the platform of a railway station thirty miles away, his son, who came to this station from a school where scarlet fever was then prevalent. The two spent an hour and a half together and then returned to their respective quarters. Within the next four days, the lady of the house to which the father returned fell ill and died of malignant scarlet fever. The father and son remained well." Although every effort was made to find the cause elsewhere, no other source of infection than the above could be discovered. That milk may, in certain instances, be the source of infection has been clearly proved, though it is highly probable that it acts merely as a carrier of the contagion, and bears no etiological relationship to the development of the specific virus. In England, America, and Germany definite outbreaks of scarlet fever have been traced to a contaminated milk-supply, though the attempts to establish any definite scientific connection with a disease existing at the same time in a particular herd of cows has failed. In almost all instances it has been shown that the contagion of the milk arose through its exposure to the disease in man, and, when it has not been possible to do this, we must assume that some such outside agency has been the source of infection. Knowing the great tenacity of the poison of scarlet fever, the possibility of such undetected sources of contagion must be granted.

In France, on the other hand, Moizard[376] states that outbreaks of scarlatina traceable to an infected milk-supply have never been observed; and regards this alleged relationship in countries where scarlet fever is extremely common as of very little etiological value. May there not be, however, some relationship between the freedom of France in this respect, and the suggestive conclusions arrived at by Hall (*loc. cit.*). It is well known that in France, in the vast majority of cases, children are nursed by their mothers, or by wet-nurses, for in almost no other country has the system of wet-nursing been carried to the same extent. Hall further states "that, in countries where goats' milk and asses' milk are used as a food, scarlet fever is unknown." It is difficult to believe that cows' milk alone is capable of becoming a source of contagion. If cows' milk may be the carrier of the poison, why not goats' and asses' milk also? These are questions that time alone can answer.

[375] See Allbutt's "System of Medicine" (*loc. cit.*, p. 129).
[376] *Loc. cit.*, p. 118.

The great danger in an infected milk lies in taking it in the raw or natural state; boiling has been shown to do away with the power of infection.

The two cases cited above (see page 233), as illustrating the means of the spread of scarlatina, serve well also to demonstrate the great *tenacity* of the poison, which often, in spite of vigorous efforts to destroy it, remains latent, and at some subsequent time lights up a fresh epidemic, the exact source of which it may be most difficult to determine. Murchison (*loc. cit.*) cites an interesting instance of the tenacity of the specific virus, occurring in spite of the best conditions for thorough disinfection. During an epidemic of scarlet fever in St. Thomas's Hospital, London, one ward was set apart for this disease. For two years subsequent to this outbreak, though this ward had been thoroughly cleaned, disinfected, and even painted immediately after the subsidence of the epidemic and yearly thereafter, all the children sent into it developed scarlatina.

Hatfield[377] relates an extraordinary case, in which the contagion survived two generations, being packed away in a chest of clothes for thirty-five years, after this lapse of time communicating the disease to a grandchild, for whom some of the grandfather's clothes had been made over.

From these cases it is evident that the poison of scarlet fever may retain its contagious properties indefinitely, and may exist for years under circumstances which absolutely preclude any fresh access of contagion. This tenacity seems to depend in no way upon the surrounding conditions, but rather upon the essential virulence of the contagion alone.

When Contagious.—In spite of the conflicting statements of many observers as to the period during which the disease may be transmitted, the weight of the evidence establishes the fact, beyond a doubt, that scarlatina is contagious from the appearance of the earliest symptoms until after desquamation is complete. Eichhorst (*loc. cit.*, p. 230) says that it is least contagious during the period of incubation, most pronounced at the time of the eruption, and that, with the establishment of convalescence and advancing desquamation the power of contagion steadily diminishes. Osler[378] states that "the contagion of scarlet fever is probably not developed until the eruption appears, and is to be par-

[377] Hatfield (M. P.): "Scarlet Fever," in "American Text-book of the Diseases of Children" (Philadelphia, 1894), p. 157.

[378] Osler (W.): "Practice of Medicine" (New York, 1896), p. 71.

ticularly dreaded during desquamation"; while Holt affirms that infection is doubtless most active during the febrile period, and places the average duration of the contagious period at six weeks. According to Sanne,[379] contagion is most to be dreaded during the period of desquamation. Lemoine,[380] on the other hand, has reported several cases in which soldiers, convalescent from scarlet fever, had returned either to their barracks or home before desquamation was complete, and yet did not spread the disease. In a disease in which individual susceptibility and idiosyncrasy play so large a part, it is necessarily difficult to form an accurate judgment in isolated cases; but that scarlatina may be contracted during the earliest stages of an attack is proved by the celebrated case quoted by Trousseau.[381] A London merchant, who had been spending the winter in Pau with one of his daughters, planned, on his return to England, to stop over in Paris for several days. His eldest daughter, who had been keeping house in England during his absence, anxious to meet her father and sister, went on to Paris. While crossing the channel she was seized with fever and a sore throat. Seven or eight hours later she arrived in Paris, reaching the hotel but a short time after her sister and father had arrived from Pau, and came down with a severe attack of scarlet fever. Within twenty-four hours it developed in her sister as well. There had been no scarlet fever in Pau, but it was epidemic at this time in London.

Evidence of the transmissibility of the contagion, even after the disappearance of all the signs of desquamation, is not wanting. In proof of this Bond[382] cites the following instance: A child was sent out from the hospital six weeks after the onset of a mild attack of scarlet fever, without having shown for fifteen days the slightest trace of desquamation. He returned home, every necessary precaution as to disinfection having been carried out, and was allowed to occupy the same bed with his small sister, who, five days later, developed scarlet fever.

Wood[383] relates an almost parallel instance. In these cases the tenacity of the contagious element seems to favor the theory of Lemoine, that the poison is very largely present in the throat, and in this locality may remain virulent after all evidence of the disease has disap-

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[379] Sanne (A.): In Barthez et Sanne: "Traité Clinique et Pratique des Maladies des Enfants" (Paris, 1891).

[380] Lemoine (G. H.): Bull. et Mém. Soc. Méd. des Hôp. de Paris, 1895, III S., xii, pp. 738 *et seq.*

[381] See Trousseau (*loc. cit.*, p. 172).

[382] Bond: Brit. Med. Jour., February, 1887, p. 277.

[383] Wood (H. C.): Therap. Gaz., vol. i, 1889, p. 739.

peared. Situated here, it must escape the general disinfection to which the body is submitted. Under the above circumstances it is difficult, at least, to assume the epidermic scales to have been the carrier of the contagion. Thomas (*loc. cit.*, p. 178) believes that there is no satisfactory evidence to prove that the contagion is situated either exclusively or even chiefly in the epidermis, and that it may be presumed that the contagion enters from the blood into all the secretions and excretions of the patient. Thus, it is evident that the contagion of scarlet fever may be transmitted from the moment of appearance of the earliest symptoms until after all evidence of the disease has disappeared, though it still remains impossible to determine the exact moment at which the contagiousness ceases.

Individual Predisposition.—In general, the predisposition to scarlet fever is much less common than in the case of small-pox and measles, while, at the same time, individual susceptibility varies greatly both as regards exposure and the severity of the infection. Certain individuals, though repeatedly exposed, and even though they may be the means of spreading the contagion to others, do not themselves contract the disease. On the other hand, the members of some families show a marked susceptibility to, and but slight powers of resistance against, the virulence of the poison. In some instances an individual who has been repeatedly exposed to an intensely severe infection escapes, only to contract the disease at some later time. That individual susceptibility does not always bear a distinct relationship to the virulence of the contagion is borne out by those not infrequent cases in which two members of the same family contract the disease from the same source, and yet show a great difference in the severity of the infection; or even in those instances in which, though exposed, but one individual succumbs to the poison. In the history of epidemics of scarlet fever appearing in a given locality after a long period of freedom from the disease, an apparent immunity on the part of some individuals has been observed which, under the influence of the presence of the contagion, has gradually diminished and given place, in subsequent outbreaks, to a more general predisposition on the part of the individuals in those households which had hitherto escaped. That the conditions under which an outbreak of scarlatina occurs, whether in a scattered or a crowded population, should in some measure influence the predisposition to the infection, would seem at least plausible, but any such definite relationship cannot, in every instance, be established.

In the epidemic occurring in the Canary Islands (see p. 171),

where, for a lapse of fifty-seven years there had been no scarlet fever, this is well illustrated by the villages of Haldersvig and Eide, both subjected to like conditions of climate, temperature, soil, etc.; the former having a rather scattered population, while the latter was very closely built up. In Haldersvig, with 161 inhabitants, there were 58 cases of scarlatina (36 per cent.).[384] In Eide, with 305 inhabitants, there were 6 cases of scarlatina (2 per cent.). Contrasting the susceptibility of these same islanders to the contagion of scarlatina and measles, the difference is striking.

In 1846,[385] during an epidemic of measles in these islands, which lasted but a comparatively short time, three-fourths of the entire population contracted the disease; while during this epidemic of scarlet fever, which continued over many months, but one-eleventh of the whole population suffered.

Social conditions, though, in a measure, influencing the mortality of scarlet fever, seem to exert no appreciable influence upon individual susceptibility. Rich and poor alike, when exposed, show no marked difference in this respect. The statements of various authorities differ greatly on this point: a fact which seems in itself proof that there can be no great difference in the predisposition of the better classes and that of less favored individuals. Forchheimer (*loc. cit.*, p. 22) has even demonstrated that in Berlin, from 1876 to 1883, the mortality was less among those occupying the lower than in those occupying the upper floors of the same tenements, being greatest upon the fourth floor, which, though generally more crowded with tenants, had surely a better air than the lower stories, and admits of no traceable connection with the soil.

That the mortality from scarlet fever is greater among the poor is due to the fact that they cannot avail themselves of the same care and skill which is afforded the rich.

Age has a very pronounced influence upon susceptibility to the contagion of scarlet fever, childhood, in a marked degree, predisposing to the disease. That it occasionally occurs late in life, as well as in the earliest months, is well established; though the statement made by some writers, that scarlet fever may be congenital, seems to us, in the light of our present evidence, untenable. The figures collected by Hoff[386] from the outbreak in the Canary Islands are interesting:—

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[384] See von Jürgensen (*loc. cit.*, p. 5).
[385] *Ibid.*, p. 9.
[386] *Ibid.*, p. 10.

In Thorshavn, out of 343 inhabitants between the ages of 0 and 20 years, 193 (or 56.3 per cent.) contracted scarlatina.

Out of 582 inhabitants over 40 years of age, 44 (or only 7.6 per cent.) developed the disease.

Murchison's[387] statistics of 148,829 deaths from scarlatina in England and Wales in 1847, and from 1855 to 1861 illustrate the frequency of the disease at different ages:—

				Males.	Females.	
Under	1	year,	9,999	5,575	4,424	6.7 per cent.
From	1-2	years,	20,975			
"	2-3	"	23,842			
"	3-4	"	22,528			
"	4-5	"	17,726			
Under	5	"	95,070	49,157	45,899	63.8 per cent.
From	5-10	"	38,591			
"	10-15	"	8,676			
Total,	5-15	"	47,267	23,242	24,025	31.7 per cent.
From	15-25	"	3,871			
"	25-45	"	1,971			
"	45-65	"	516			
"	65-85	"	118			
"	85-95	"	4			
Over	95	"	6			
From	15-95	"	6,492	2,964	3,528	4.3 per cent.
			Total	75,373	73,456	

Johannessen[388] has further classified 1040 deaths from scarlet fever in Norway between the years 1862 and 1878 as follows:—

During	the	first	year	1st month	0 cases.	
"	"	"	"	2d-3d "	3 "	
"	"	"	"	4th-6th "	12 "	
"	"	"	"	7th-12th "	87 "	9.3 per cent.
During	the	second	year		43.0 "	"
"	"	4th-5th	"		22.6 "	"
From	"	5th-10th	"		20.5 "	"
"	"	11th-15th	"		2.3 per mille.	

[387] See Murchison: The Lancet (*loc. cit.*).

[388] See Johannessen (*op. cit.*, p. 86).

Tripe,[389] in a given 1000 deaths from scarlet fever, has arranged them according to the years at which they occurred:—

During the	1st	year	65	deaths.
From	1-2	years	147	"
"	2-3	"	165	"
"	3-4	"	149	"
"	4-5	"	120	"
"	5-15	"	316	"
"	15-25	"	22	"
"	25-45	"	14	"
"	45-65	"	2	"
Total.....			1000	

From the above figures it is evident that the greatest number of cases occur between the ages of one and five, while next in frequency comes the period between five and fifteen, after which the number of cases rapidly diminishes. It is seen that the percentage during the first year is comparatively small, being but 6.7 per cent., 9.3 per cent., and 6.5 per cent., respectively.

The influence of *sex* exerts but very slight effect upon the individual predisposition to scarlatina. Up to the age of fifteen the greater number of cases are seen in males; after this period there is a slight increase in favor of the opposite sex, though the total percentage for both sexes is commonly greatest in males.

In the figures given by Murchison (see above) the results are: 50.7 per cent. for males, as against 49.3 per cent. for females.

Certain other conditions very markedly increase the predisposition to scarlatina. Among these convalescence from surgical operations and the existence at the time of exposure of accidental wounds deserve mention. Exceptions, here as elsewhere, occasionally occur, and the writer well remembers an instance, in which he was present at a laparotomy, the sole onlooker in a small operating-room, and six hours later developed a severe septic scarlatina, while the patient, unconsciously exposed in this way, remained well and made a good recovery.

The danger of confusing the various types of post-operative or traumatic erythema with the true scarlatinal eruption must be admitted; and so long as the diagnosis of "surgical scarlatina" continues to be made on the basis of the rash alone, such mistakes must inevitably occur.

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[389] Tripe (J. W.): "The Mortality from the Eruptive Fevers at Different Periods of the Year" (London, 1857).

The term "scarlet fever," however, must be limited to those cases in which, in addition to the eruption, other typical symptoms of the disease, such as angina, glandular swelling, desquamation, or even subsequent nephritis, are present. Hoffa[390] has divided these post-operative scarlatinoid erythemas into three classes: the congestive, the toxic, and those associated with general sepsis. (1. Erythema Congestivum. 2. Erythema Toxicum. 3. Affections of the skin associated with sepsis.)

Sir James Paget[391] holds that, in the cases of post-operative scarlatina described by him, the patients were infected prior to operation, and that the onset of the attack was hastened by the necessarily lowered vitality of the patient. Knowing the tenacity of the scarlatinal virus, it is, of course, impossible to exclude a previous infection in all such cases; but, as a rule, whether exposed previous or subsequent to the operation, the susceptibility of the individual to the poison is usually increased. Henoch[392] has called attention to the great susceptibility of children, the subjects of operative wounds for phimosis, tracheotomy, and of wounds about the eyes; while Hagenbach[393] has further noticed the unusually short period of incubation, in addition to the increased susceptibility of patients with tracheotomy wounds

Bruner[394] has reported five cases, in which, following local post-operative erysipelas, a general scarlatinal attack has developed. From all the evidence we are justified in assuming that the presence of accidental or operative wounds in some way lessens the resistance of the individual against the scarlatinal poison. With the modern methods of thorough and exact asepsis, and antisepsis, it has been shown that, in the case of surgical wounds, subsequent scarlatinal infection is becoming of far less common occurrence.

Puerperal Scarlatina.—Henoch[395] is of opinion that the well-recognized susceptibility to scarlatina of women recently confined is referable, in some measure, to the same conditions which prevail in the surgical cases, namely: the existence of a large surface admitting of ready absorption of the poison, associated with weakened power of resistance on the part of the individual. Here, again, we must distin-

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[390] Hoffa (Albrecht): In von Volkmann's Sammlung klin. Vorträge, No. 292 (Chirurgie, No. 90), 1886-87, pp. 2679 *et seq.*

[391] Paget (Sir James): Brit. Med. Jour., 1864, ii, 237.

[392] See Henoch (Vorles., *loc. cit.*, p. 682).

[393] Hagenbach (*loc. cit.*, p. 115).

[394] Bruner (K.): Berliner klin. Woch., 1895, No. 22, pp. 469 *et seq.*

[395] See Henoch (*ibid.*, p. 682).

guish the so-called "puerperal scarlatina," which is but the expression of a severe general septic infection, with an erythematous rash simulating a scarlatinal eruption, from true scarlet fever. Von Jürgensen[396] calls attention to the fact that the greatest number of cases of scarlet fever occurring during the lying-in period are reported from England; and considers it established beyond a doubt, from the statistics published by Braxton-Hicks and others, that the women of Great Britain are more often subject to puerperal erythemas than the women of Germany; but is inclined to question the significance of these erythemas in every case. According to Runge,[397] the existence of scarlatina is not an altogether infrequent complication of the puerperium, but he says this is apparently much more frequently seen in England, though isolated cases, and even epidemics in institutions, have been reported in Germany and from Switzerland.

Of the susceptibility of lying-in women to the poison of scarlatina, there can, however, be no question; and the number of cases reported in literature establish beyond a doubt its all too frequent occurrence. It is, of course, possible that many cases of so-called scarlatina are, in reality, simple septic infection. Infection may occur during pregnancy, or at the time of confinement. As a rule, the disease develops during the first days of the puerperium, and follows the same course seen in adults under normal circumstances, with the exception that the angina may be less marked, and the intestinal symptoms not infrequently more pronounced.

The existence of other *infectious diseases* in an individual at the time of exposure exerts no special disposition either toward or against the poison of scarlet fever. Occasional instances are reported in which scarlatina has developed during or closely following an attack of measles, variola, varicella, and typhoid fever, and more rarely mumps and erysipelas. In such cases it usually runs its course modified but slightly by the pre-existing infection.

Acquired Immunity.—As a rule, one attack of scarlatina protects against a subsequent infection, though the immunity is by no means an assured one, and second, and even third, attacks have been reported. In considering the question of a positive diagnosis of a second attack one must exclude, of course, all conditions which are dependent in any way upon the first attack, and which should be considered as relapses.

A second attack can only justly be held to be such, when it ap-

[396] Von Jürgensen (*loc. cit.*, p. 23).

[397] Runge (M.): "Lehrbuch der Geburtshulfe" (Berlin, 1898), p. 564.

pears some time after the disappearance of the symptoms of the first attack, and can have no possible relationship with it. In this connection it is interesting to note that Henoch[398] has seen but one authentic case of a second attack of scarlatina, and further cautions against confusing the simple febrile erythemas with the true scarlatinal eruption. Instances of a third, and even a fourth, attack have been reported by Murchison [399] and Stiebel,[400] respectively. According to Körner,[401] when a second attack occurs, it usually follows from two to six years after the first, which most frequently occurs, in such cases, before the age of ten. The second outbreak is, as a rule, no milder than the first, and may even be much more severe.

Epidemic Type.—There are certain characteristics, if such we can call them (for, in reality, it is the absence of distinct characteristics), which give to the symptom-complex known as scarlatina a unique place among infectious diseases.

In our present ignorance as to the precise nature of the scarlatinal virus and the conditions influencing its life-history, an attempt to establish a relationship between sporadic cases or single epidemics of this disease and the conditions under which they occur, and which should, we assume in some measure at least, modify the prevailing type, must be, to a large extent, provisional.

It is as impossible to explain the great variation seen in different epidemics, which may range in mortality from 3 to 30 per cent., as it is to explain such great variation in the severity of the infection in individual cases, often seen in members of the same household. Scarlet fever shows a variation in the epidemic type far more striking than that seen in any other disease: a variation controlled apparently by no laws and governed by no semblance of regularity. During the early years of its appearance on the North American continent the disease prevailed in a very mild type; later, epidemics of great malignancy occurred which, in turn, were succeeded during the 30's by outbreaks of a type so mild that the contagiousness of the disease was questioned. In Ireland[402] the same striking variation was seen between the epidemics which devastated the country from 1800 to 1804, and the long subsequent period of mild outbreaks lasting until 1831, fol-

[398] See Henoch (*loc. cit.*, p. 683).

[399] See Murchison (*loc. cit.*).

[400] See Thomas (*loc. cit.*, p. 192).

[401] Körner: "Jahrb. f. Kinderh., N. F.," vol. ix, p. 362.

[402] See Graves and Gerhard: "System of Clinical Medicine" (Philadelphia, 1848), pp. 421 *et seq.*

lowed in this year and again in 1834 by epidemics of frightful malignancy. Trousseau[403] has called attention to the sudden and rude contradiction of his master Brettoneau's teaching, who had not seen a death from scarlatina from 1799 to 1822, and regarded it as a comparatively mild affection, until, in 1824, an epidemic of unusual severity broke out in Tours, which proved fatal in many cases.

In contrast with the epidemic type of measles, which usually extends over a given area with more or less rapidity and limitation as regards time, burning itself out or exhausting the favorable conditions for the development of the poison, epidemic scarlatina may show a much more irregular and protracted course, often covering a period of months, when the duration of the epidemic of measles has been as many weeks. This difference is well illustrated in the epidemics occurring in the Canary Islands, noted above (see p. 171).

By some authorities an attempt has been made to establish a certain periodicity for epidemics of scarlatina, at least, in given localities; and, in many instances, this periodicity is quite marked, but with far less regularity than is the case in measles. Again, certain groups of years, as pointed out by Hirsch,[404] have been marked by wide-spread epidemics of scarlatina, throughout distantly separated countries: a fact which would seem to point to far-reaching atmospheric or climatic conditions as in some way influencing the spread of the disease.

DIAGNOSIS.

The presence of scarlatina in all our large cities, and not infrequently throughout the less closely settled suburban districts, in a more or less endemic form, associated with the outbreak of single, scattered, and anomalous cases, renders the question of diagnosis a most important one. As is true of all the acute exanthemata, its occurrence in epidemic form is invariably of great help in determining the diagnosis of a doubtful case.

Although in a typical case of scarlet fever the diagnosis of the infection may be simple, there are many conditions under which it is often extremely difficult to arrive at a definite conclusion regarding the actual nature of the attack. Particularly is this true when, in the absence of any epidemic of scarlatina, the case under observation is seen for the first time early in the course of the disease, before the appearance of the characteristic symptom-complex, which frequently alone

[403] See Trousseau (*loc. cit.*, p. 137).

[404] Hirsch (*loc. cit.*, p. 129).

justifies one in determining the essential character of the disease under consideration. The absolute necessity of arriving at a definite conclusion at the earliest possible moment is, perhaps, no greater in any of the acute exanthemata than in scarlatina; and in every instance when there is the slightest doubt the case should be suspected from the outset, and at least considered as scarlatina until the subsequent developments establish its character beyond question. In a small percentage of cases, characterized by an abrupt and overwhelming toxæmia, which prove fatal in from twenty-four to seventy-two hours, it may be absolutely impossible to determine the nature of the affection during the life of the patient, and only the subsequent development of typical scarlatina in the same household clears up the diagnosis in the first case. These instances are, however, happily rare. Again, in a slightly larger proportion, cases characterized by early marked involvement of the pharynx, with but a poorly defined, irregular, transient, or wholly absent exanthem, may present great difficulties in diagnosis.

As Mayr (*loc. cit.*, p. 219) truly says: "The diagnostic signs of scarlatina are these: the existence of a special efflorescence; its mode of distribution over the cutaneous surface; the inflamed state of the parts concerned in deglutition; the peculiar desquamation; the spreading of the disease by contagion; its epidemic occurrence; the febrile symptoms which accompany it; and, lastly, the sequelæ to which it gives rise." With the existence of all of the above symptoms the diagnosis of scarlet fever would, indeed, be a simple matter, but many of them are too frequently wanting, and one is hardly prepared to await the development of the specific sequelæ, if such delay can be avoided, before reaching a conclusion as to the nature of the disease. During the stage of incubation there are, as a rule, no evidences of the threatened attack, and no symptoms characteristic of this or any other specific infection. With the development of the prodromal stage and the early initial symptoms, it first becomes possible to form an opinion as to the nature of the attack. Too great stress cannot be laid upon the necessity of withholding, in all doubtful cases, the expression of a positive opinion for twenty-four hours or even longer, at least until the disease has declared itself absolutely. As characteristic early symptoms of a typical scarlatinal infection we have, during the first twenty-four hours, the abrupt onset, associated with more or less marked constitutional depression, headache, intense redness and congestion of the faucial mucous membrane, sore throat, often early and persistent vomiting, occasionally convulsions, and a rapid rise of temperature, together with a

rapid increase in the pulse-rate. This sudden onset—when accompanied by headache, sore throat, and general prostration—is peculiarly suggestive of scarlatina.

Vomiting is seen at the beginning both of pneumonia and smallpox, but in the absence of marked angina, unless accidentally present, and with the existence of other symptoms characteristic of the two latter diseases, it should be differentiated from that due to scarlatina. Vomiting of central origin, due to the involvement of the brain or meninges, is extremely rare at the age of greatest susceptibility to scarlatina, excepting in cases in which there could hardly be any great confusion of symptoms. According to von Leube (*loc. cit.*, p. 414), vomiting in scarlet fever is an initial symptom of the greatest diagnostic value, occurring more often in this disease in childhood than in any other, with the exception of pneumonia.

Convulsions in childhood may also mark the onset of measles, pneumonia, diphtheria, of acute cerebro-spinal meningitis, poliomyelitis, and encephalitis; and in young children may be the result of many conditions dependent upon reflex disturbances of a mild or severe type. In all such cases one must await the development of other characteristic symptoms before making a diagnosis.

The early sore throat of scarlatina is almost as constant and characteristic as the eruption. Locally there is present, usually from the first, a diffuse, mottled, congested appearance of the uvula, soft palate, pharyngeal arches, and even the tonsils, while the latter are swollen and their follicles prominent and not uncommonly filled with exudate. The early enanthem develops, as a rule, within the first twenty-four hours, and differs essentially from that seen in measles, having more the character of a widely scattered punctate blush, and lacking the sharply defined, slightly elevated, pin-head, papillary areas of pale, grayish white,—seen in the enanthem so characteristic of measles. Not infrequently the condition of the throat closely resembles a follicular tonsillitis, and in the absence of other symptoms an error in diagnosis may easily be made.

There is nothing peculiarly characteristic in the early temperature of scarlet fever. It rises abruptly with the onset of the disease, remaining elevated throughout the febrile period, showing a slight diurnal variation, and falling by lysis, toward the end of the first week, to normal. Measles, on the other hand, shows during the second and third day of the attack a decided remission in the temperature, which rises again with the development of the exanthem.

In a large majority of cases the pulse-rate increases rapidly, very commonly out of all proportion to the height of the fever,—a point to which attention has already been called,—and frequently maintains this disproportion throughout the febrile period.

During the *second twenty-four* hours, in addition to the symptoms noted above, which usually increases in severity, the characteristic eruption develops, accompanied by enlargement of the superficial lymphatic glands. Occurring first upon the upper thorax and spreading quickly over the throat, neck, chest, extremities, and trunk, with but slight involvement of the face, the exanthem appears as a diffuse scarlet blush, which, upon closer inspection, is seen to be made up of minute, punctate, reddened spots, separated by areas of pale skin. In such a case, when associated with the early symptoms of the disease, the diagnosis is usually not difficult. In the absence, however, of one or more of the initial symptoms, the appearance of an eruption closely resembling that of scarlatina may give rise to great confusion, while an anomalous development of the eruption associated with any one of the early symptoms may lead to equally great uncertainty.

Erythema.—The similarity between the eruption of scarlatina and a simple erythema is frequently striking. The fleeting character and great variability of the latter, together with little or no fever and but slight, if any, constitutional symptoms, and the absence of angina and enlargement of the lymphatic glands of the neck, will serve to differentiate it. In this connection it is to be noted that in all forms of erythema of the skin the mucous membrane of the palate may also be affected. In all erythemas, upon close examination, there will be noticed an absence of the minute, punctate, reddened spots characteristic of the early scarlatinal exanthem.

Drug Eruptions. — Belladonna, opium, quinine, and antipyrin may, in rare cases, give rise to an erythematous eruption almost identical with that of scarlatina: a condition which can be differentiated from true scarlet fever by a careful analysis of the symptoms present, together with a knowledge of the history of the case. As a rule, the exanthem appears first on the face and neck, spreading gradually over the entire body, and is seen most frequently following the administration of quinine. The danger of confusion lies in the presence of more or less fever and the slight constitutional symptoms for which the drug has been given. When doubt exists, the discontinuance of the drug will be followed by a disappearance of the rash, and, as in both scarlatina and measles, by the occurrence of a branny or lamellar

desquamation. Guinon[405] has reported a case in which antipyrin produced a scarlatiniform eruption associated with angina and intense fever. As a rule, the eruption of antipyrin is a polymorphous erythema and does not resemble scarlatina so closely as measles. Morel-Lavallée[406] has called attention to a much rarer occurrence, namely: the remarkable similarity between the erythema sometimes produced by mercury and the exanthem of scarlatina. Ordinarily uncomplicated by fever or angina, the severe cases may be associated with fever and even with desquamation of the tongue, and are apparently anatomically identical with the scarlatinal eruption even as regards the cutaneous desquamation, making the diagnosis, in the absence of the history, almost impossible.

Chloral is, in rare instances, followed by an erythematous eruption of the skin simulating the scarlatinal rash, together with redness of the pharyngeal mucous membrane and a rise of 1 or 2 degrees in temperature. The absence of the angina, with the mild constitutional symptoms and the history of the administration of the drug, will aid in diagnosis.

Erythema scarlatiniforme, which not infrequently appears suddenly as a bright erythematous, punctiform rash closely resembling the eruption of scarlatina, may be distinguished from the latter by its irregularity of distribution, and by the fact that it does not, as a rule, begin in any given locality, and is, further, frequently sharply defined in certain areas, as beside the nose. The constitutional symptoms are slight; the temperature may reach 100° to 101° F., but subsides quickly. The fauces are reddened, but there is no angina. The disappearance of the rash may be followed by desquamation: as a rule, furfuraceous in character.

Erythema scarlatiniforme desquamativum—under which name the French writers have described a condition closely resembling the above, characterized by a diffuse erythematous rash, slight angina, mild constitutional symptoms, and followed by desquamation—may simulate scarlatina, rendering the diagnosis, in some cases, extremely difficult. Here, again, the eruption is frequently limited to certain areas, which may be sharply defined, and shows a greater tendency to become diffuse than punctiform, while the duration of the rash is commonly much longer than is the case of scarlatina. In cases in which the mucous

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[405] See Moizard (*loc. cit.*, p. 153).

[406] Morel-Lavallée (A.): Revue de Méd., 1891, xi, pp. 449 *et seq.*

membranes are involved, the tongue may peel and become smooth and red, lacking, however, the characteristic changes seen in scarlet fever. The absence of marked constitutional symptoms, of the "strawberry" tongue, and of any marked swelling of the fauces, together with the slight involvement of the superficial lymphatic glands, and the history of similar attacks—for it shows a marked tendency to recur—will further aid in the diagnosis. The writer has notes of a case of this character in which the patient had repeated attacks in a certain locality, and remained free from the disease while residing in another city not more than thirty miles distant.

In this connection the following case is of sufficient value to be given in detail, as illustrating the difficulty of establishing a diagnosis without reference to the history, and further in proof of the statement already made that the appearance of a characteristic desquamation is by no means always an infallible sign of recent scarlatina[407]:—

M. D. Aged 20. As a child she had measles, chicken-pox, and diphtheria. With the exception of the history given below, her health has been generally good. In 1891, when eleven years of age, she went through a severe attack of scarlet fever. Her younger sister, ill at the same time, died from the effects of the infection.

In 1894 she had what was apparently a typical attack of erythema scarlatiniforme desquamativum, following which she remained well until April, 1900, when she went through a similar attack, which lasted two weeks. In May she had a third similar illness lasting seven weeks; and again on August 26th of this year (1900) a fourth attack.

When first seen on the second day of this last illness, there was some slight rise of temperature, which lasted but a day or two, while the pulse-rate was correspondingly quickened. The mucous membrane of the mouth and pharynx was congested, showing everywhere a diffuse redness; the tongue was coated, the tip and edges reddened, and the eruption typically scarlatiniform in character. A bright scarlet blush was well marked over the entire body.

The eyes were congested, reddened, and watery, and the conjunctivæ somewhat inflamed; photophobia was marked, the condition of the eyes being more typical of the early catarrhal inflammation seen in measles. The urine was negative.

By the seventh day of the attack all the acute symptoms had sub-

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[407] The writer wishes to express his indebtedness to Dr. Corlett for the privilege of seeing this remarkable case.

sided, and desquamation was advancing rapidly, the characteristic scaly flakes being present on the trunk and arms, while on the feet typical lamellar desquamation was marked.

Erysipelas should ordinarily be easily differentiated from a true scarlatinal eruption by the peculiar character of its development, extension, and commonly, its localization. Rarely the occurrence of an erysipelatous eruption in a woman, known to have been exposed just previous to or immediately following confinement, or in those the subjects of operative wounds, may lead to confusion in diagnosis, which only subsequent facts can satisfactorily clear up.

The enlargement of the *superficial lymphatic glands* during the second twenty-four hours of the attack is, perhaps, of but slight diagnostic value, and yet in a doubtful case might well be of great significance. Von Jürgensen (*loc. cit.*, p. 222) emphasizes the diagnostic importance of early enlargement of the inguinal glands in scarlet fever. Schamberg (*loc. cit.*), in his analysis of a hundred cases, says: "In differentiating the rashes of diphtheria from true scarlatina the study of the glands is, perhaps, of inconsiderable value. A well marked enlargement of all the superficial glands, particularly the epitrochlear and axillary, would, in doubtful cases, tend to throw the balance in favor of scarlet fever." Further: "In distinguishing between scarlatina and measles an examination of the glands lends but little aid, . . . it is to be noted, however, that the adenopathy of measles is not nearly as well marked as that observed in scarlet fever." As an aid in distinguishing between the scarlatiniform erythemata, in which there is but slight glandular involvement, and true scarlatina, the enlargement of the lymphatic glands in the latter may, however, be of real value.

From the third to the sixth day, and occasionally earlier, those changes in the *tongue*—which, in association with other constitutional symptoms, are so peculiarly characteristic of scarlet fever—are usually well marked. Certain rare conditions of a chronic character may more or less closely simulate the "strawberry tongue" of scarlatina, but the absence of all other symptoms renders the diagnosis easy. The early injection and enlargement of the papillæ at the tip and edges of the tongue is peculiarly characteristic of scarlatina, and frequently of great diagnostic value. Among the acute exanthemata the differential diagnosis between scarlatina and measles, or scarlatina and German measles, often presents many difficulties, and, in the absence of other general symptoms, when the exanthem alone must largely determine the diagnosis, great confusion may arise.

In cases characterized by an irregular, patchy eruption upon the extremities and elsewhere, or when the rash is, as rarely happens, of a roseolar, confluent type, it may suggest strongly, at first glance, the eruption of measles. In these cases one must await further developments before expressing an opinion.

Measles.—The chief points of difference between scarlatina and measles may be found under "Measles," p. 321, also in table at the end of the volume.

Rubella, or German Measles.—While rubella is, perhaps, more frequently confused with measles than with any other affection, in certain cases characterized by an irregular or roseolar eruption confusion in diagnosis may arise. The differential diagnosis between scarlet fever and rubella will be found fully considered under the latter disease (see page 369).

Small-pox.—The early rash preceding the formation of the pustules in small-pox may bear a striking resemblance to the eruption of scarlet fever, a full discussion of which will be found under "Variola" (see page 89).

Diphtheria. — The differential diagnosis between scarlatina and diphtheria may, in certain cases, present great difficulty, the occurrence of the false membrane in the pharynx, and the not infrequently coincident development of a transient toxic erythema in diphtheria closely resembling conditions seen in scarlet fever. Fortunately, in doubtful cases early and prompt isolation would in either case be insisted upon. In a small percentage of cases scarlatina may develop under conditions which have admitted previous exposure to diphtheria, and a diphtheria may be present complicating early scarlet fever. It is an interesting clinical fact that, when diphtheria is the secondary invader, this complication occurs more often late in the course of the disease, after the disappearance of the scarlatinal angina; when, however, scarlet fever is the secondary invader, it is perhaps more frequently seen early in the attack of diphtheria. Cases characterized by the presence of other micro-organisms, as the streptococcus pyogenes, are examples of so-called mixed infection, and such is the condition commonly seen in the early scarlatinal anginas complicated by diphtheria, as well as often in diphtheria occurring late in the attack.

As a rule, the onset in diphtheria is much less abrupt, and the constitutional depression frequently more pronounced than in scarlatina, the actual attack being preceded by a period of two or three days during which the patient complains of vague pains in the back and

limbs, or slight chilly sensations. In scarlatina the violent onset and pronounced initial symptoms are commonly the first indications of the threatened infection. In young children convulsions may mark the onset of both diphtheria and scarlatina. The mucous membrane of the pharynx, early in the course of diphtheria, is congested and reddened, lacking, however, the characteristic mottling of the scarlatinal enanthem. Upon this point, however, too great reliance must not be placed. Difficulty and pain on swallowing may be present as in scarlatina.

The early appearance of the false membrane upon the tonsils, usually on the first or second day in diphtheria, and its late development in the severe diphtheroid angina of scarlet fever are points of great diagnostic value. Finally there is less tendency to invasion of the larynx in the streptococcic scarlatinal angina than in diphtheria.

In those cases of diphtheria in which there is no manifestation of a local membrane, but which present a simple catarrhal angina, the diagnosis as between diphtheria and a mild scarlatina without exanthem may be impossible without bacteriological proof of the presence of the Klebs-Loeffler bacillus.

When, in addition to the general and local pharyngeal symptoms, a diffuse, dark or lighter scarlet erythema appears upon the trunk, extending rapidly over a more or less limited area, frequently fading where first seen, as it advances, or disappearing only to reappear again, the diagnosis may be unusually difficult. In these instances the color of the eruption, which is frequently darker than the scarlatinal rash; its situation, subsequent development, and irregular distribution, and its fleeting nature; together with the absence of the punctiform character seen in scarlatina, and of desquamation, serve to distinguish it from the latter disease. Finally, the far greater liability to the occurrence of paralyses following true diphtheria, and the much greater frequency of marked renal involvement in scarlatina, are of value in determining between the two diseases. While in doubtful cases, seen early in their course, great confusion may arise, the bacteriological examination—when available—must always remain our ultimate proof. Osler says (*loc. cit.*, p. 78): "Scarlet fever and diphtheria may co-exist; but in a case presenting wide-spread erythema and extensive membranous angina, with Loeffler's bacillus, it would puzzle Hippocrates to say whether the two diseases co-existed or whether it was only an intense scarlatinal rash in diphtheria."

Tonsillitis.—The diagnosis of scarlatina from an attack of acute

follicular tonsillitis is often difficult, and may even be impossible. Slight subjective symptoms usually precede the pharyngeal inflammation; but these may be wanting and the resemblance, in many instances, to the onset of scarlet fever may be striking. Vomiting is, however, rarely present. The temperature rises rapidly, frequently touching a higher point than is seen early in the latter disease, while the constitutional depression may be extreme. The pulse is rapid, but does not show any pronounced disproportion to the fever. The early appearance of the pharyngeal mucous membrane is frequently identical with that observed in scarlet fever. The tonsils are reddened and swollen, with foci of exudate in the crypts; the tongue is coated, and swallowing is painful. Slight swelling of the cervical lymphatic glands may be present, but does not, as a rule, reach the same degree found in scarlatina, and at this time the two conditions may show a striking similarity. The absence of vomiting, of convulsions, and of severe headache are of purely negative value as an aid in diagnosis, while the temperature and the constitutional depression, frequently more marked in tonsillitis than in scarlatina, are of equally slight value in determining between the two diseases. It is, indeed, often only possible to distinguish between them with the appearance of the true scarlatinal exanthem. The occurrence of a simple erythema in tonsillitis may still further lead to confusion; but in these cases its limitation to the chest or to the neck, the absence of any punctiform character, its short duration, and the absence of desquamation would determine its nature.

The tongue remains coated throughout the course of the attack, the early injection and prominence of the papillæ is wanting, and the characteristic changes seen in scarlatina do not take place.

Influenza.—During the occurrence of influenza in epidemic form, and in the absence of any marked prevalence of scarlet fever, there is, ordinarily, little or no difficulty in distinguishing between the two conditions. In certain instances, however, under circumstances which favor the existence of both diseases, more or less confusion may readily arise. It is not wholly surprising that a disease which manifests itself in varying epidemics, and in single cases with such a shifting symptomatology, should, in exceptional cases, simulate in one way or another a true scarlatinal infection. Though the early constitutional symptoms of influenza are peculiarly characteristic, they may be absent, and in those cases characterized by a bright scarlatiniform rash associated with fever and prostration, even in the absence of any angina, the question

of diagnosis may be a difficult one, the symptoms present being those of a mild or anomalous attack of scarlet fever.

The characteristic changes in the tongue are, however, not seen, and frequently the early development of some one of the many complications of influenza, as bronchitis or pneumonia, determines the specific nature of the infection.

Cerebro-spinal Meningitis. — Acute cerebro-spinal meningitis — owing to the convulsions, sore throat, and eruption which may accompany it—is occasionally confused with scarlatina. The character of the onset and of the eruption—very unlike that in scarlet fever—and the early symptoms referable to the neck are, however, of great value as aids in differentiation.

The diagnosis of scarlet fever in the *negro* is often extremely difficult; and one is forced to rely, early in the attack, more upon the nature of the enanthem than upon the appearance of an eruption in any way characteristic of the disease. When fully developed, the rash may, as a rule, be readily detected, lacking, however, the distinct scarlet hue, and, as would be expected, being most pronounced in those localities where the pigmentation of the skin is less dark. Desquamation follows, and the general symptomatology differs in no way from that seen in the white race.

PROGNOSIS.

In no disease is the prognosis more uncertain than in scarlet fever, it being impossible to determine in any instance from the character of the initial symptoms what the ultimate result may be.

While it is true that the malignancy of different epidemics varies greatly, and the total percentage of mortality following successive outbreaks of scarlatina shows a wide range, yet the prevalence of an unusually mild epidemic type does not justify one in reaching a conclusion as to the character of single cases. Here, as elsewhere, many conditions enter into and influence the subsequent development of the infection, rendered all the more uncertain by the striking variability in the virulence of the scarlatinal poison.

Although the prognosis in a given epidemic, taken as a whole, may be good or bad, it can in any event modify but slightly that of the individual case. Thomas (*loc. cit.*, p. 291) considers an epidemic in which the mortality is below 10 per cent. as, comparatively speaking, of a benign character. Johannessen (*loc. cit.*, p. 138) found the average percentage of mortality in Norway for twelve years between 1867 and

1878 to be 12.7 per cent. Hirsch (*loc. cit.*) gives the mortality in scarlet fever as ranging from 3 to 30 per cent. In McCollom's series of a thousand cases the mortality was 9.8 per cent., and, according to this observer (*loc. cit.*), the morbidity for the city of Boston in 1898 was 16.77 per cent. Exceptionally the mortality may reach 40 per cent.

Among those circumstances which very largely affect the mortality in individual instances, and thus influence the prognosis, *social condition* plays an important part. Though it has been shown that in degree of susceptibility to the scarlatinal poison social position makes little or no difference, the difficulty of proper isolation and treatment, and, too, often the utter lack of that reserve vitality in the children of the poor add greatly to the danger of mortality. In a certain measure, this is offset in the upper classes by the occurrence of that striking *family* and *individual idiosyncrasy* which we have no means of foretelling or avoiding, and as a result of which whole families or individual members of a given household may show an unusual reaction to the specific contagion during a supposedly mild epidemic, even succumbing to the disease, while others in the same family escape with but a light attack, or even altogether.

Age affects the prognosis in general, directly, the mortality being greatest in children under six years of age. Below one year the mortality, as given by Johannessen (*loc. cit.*, p. 146) for the twelve years noted above, was 10.3 per cent. The development of scarlatina, on the other hand, in an adult not infrequently means a pronounced susceptibility on the part of the individual attacked, and the prognosis should be always extremely guarded.

Sex has little or no effect upon the ultimate outcome, except as it may imply a more robust vitality, which too often avails nothing.

With the occurrence of scarlatina during *pregnancy* or in the *puerperium*, in individuals the *subjects* of *surgical* or *accidental wounds*, as well as in the weak and enfeebled, the prognosis is *grave*.

Among those conditions which may directly affect the prognosis early in the course of the attack, the following symptoms are unfavorable: Hyperpyrexia; an extremely rapid, feeble, or *irregular* pulse; great dyspnœa and threatened collapse; persistent *vomiting* and diarrhœa; pronounced cerebral disturbance, delirium, *stupor*, or convulsions. An irregular, anomalous, or poorly developed rash, if intense, suggests extreme virulence. In mild cases the rash may be irregular, and poorly developed, but it is fainter, more evanescent, and usually associated with mild constitutional symptoms.

Later the development of severe pharyngeal inflammation and ulcerative, or membranous, angina, makes the prognosis more doubtful, while the occurrence at any period during the course of the disease, of one or more of the recognized complications brings at once an additional element of uncertainty as to the ultimate result of the attack.

Among complications most to be dreaded as affecting the prognosis are the development of diphtheria or broncho-pneumonia, marked involvement of the heart, and nephritis, with the added danger of uræmia, while the presence of a general septic infection is of the gravest significance.

In conclusion, it may be said that in no case of scarlatina, no matter how mild its onset, should one venture to express a definite opinion as to the course of the attack; nor even after the subsidence of the acute stage should one be any less guarded in affirming its final outcome, for here, far more than in any of the other acute exanthemata, there lurks an element of danger, which, appearing suddenly and unlooked for, may alter in a few hours the entire course of events, even after convalescence has been apparently well established.

TREATMENT.

In the management of scarlatina, the fact that we know so little of the essential nature of the specific virus; that we have no single rational line of treatment, based upon etiological proof; and that it is often, in a given instance, absolutely impossible to determine when or where exposure occurred, or to predict in any individual case the degree of susceptibility to the infection, add much to the difficulty in the control of the disease.

In any consideration of the treatment of scarlatina *prophylaxis* becomes at once the first and most important measure in limiting the spread of the contagion. With the development of the actual attack, the management of the disease itself and of the individual symptoms as they arise assumes the chief rôle, while, finally, the occurrence of any one of the many complications constitutes the third stage in treatment. The importance of all measures for the limitation of contagion is, of course, obvious.

Prophylaxis.—It has been clearly demonstrated, in the management of all acute infectious and highly contagious diseases, that the prompt segregation and isolation of patients is the safest and only method of limiting the further spread of the infection; and to no one

of the acute exanthemata does this apply more truly than to scarlatina. While there may be a wide difference of opinion as to the contagiousness of the disease during the early stages of its development, experience has repeatedly shown, both in hospital and private practice, that immediate isolation of the suspected case renders the danger of subsequent contagion far less than in the case of measles. That this is due in a very large measure to the weak powers of diffusibility and the difficulty of aërial infection by the scarlatinal virus seems, to the writer, highly probable. In all cities where the danger of the occurrence and spread of scarlatina is naturally greatest, the only safe and adequate method of controlling the disease is the establishment of hospitals, or properly equipped pavilions in connection with established hospitals, where such cases may be received and cared for, thereby greatly lessening the danger of its occurrence in an epidemic form. In this way only is it possible to limit materially the prevalence of scarlatina in any locality, and that such can be accomplished is proved by the fact that in one of our largest cities[408] scarlet fever has actually diminished in frequency, during the last three years, owing to the use of an isolation hospital large enough to receive all applicants for admission. Although, with the single exception of variola, no one of the acute exanthemata is dreaded in quite the same way by the public at large, who have, in many instances, learned through bitter experience to appreciate the uncertainty which lurks in every case of scarlet fever, it is constantly surprising to see the reluctance with which even the educated classes give their support to sanitary measures of this kind.

One great danger in the management of scarlatina naturally arises from the fact that there are, as a rule, no warnings of the coming attack. It repeatedly happens that children play about, apparently perfectly well up to within a few hours of the appearance of the initial symptoms, affording every opportunity for contagion and almost limitless extension of the disease. That this does not follow more frequently renders the danger no less, the one striking peculiarity of the disease being its uncertain character. In controlling the spread of scarlet fever all efforts on the part of the physician may be of little avail without the intelligent and hearty co-operation of the general public, and in furtherance of this the establishment of local boards of health for the proper surveillance of all cases arising in their territory, and for the publication of such advice as may be best, giving intelligently and

[408] See McCollom (*loc. cit.*).

plainly the simple hygienic facts for the prevention of scarlatina, is of the greatest aid. Such a bulletin published by the Michigan State Board of Health, March, 1900, for free distribution includes the following:—

"HOW TO AVOID AND PREVENT SCARLET FEVER."

(*A*) "Avoid the special contagium of the disease. It is especially important that this should be observed by children and all whose throats are sore from any cause. Children under ten years of age are in much greater danger of death from scarlet fever than are adults; but adult persons often contract and spread the disease, and sometimes die from it. Mild cases in adults may thus cause fatal cases among children. Because of these facts it is frequently dangerous for children to go where adult persons go with almost perfect safety to themselves."

(*B*) "Do not let a child go near a case of scarlet fever. Do not permit any person or any animal to come, or anything to be brought, directly from a case of scarlet fever to a child. Unless your services are needed, keep away from the disease yourself. If you do visit a case, bathe yourself and change and disinfect your clothing before you go where there is a child."

(*C*) "The contagium of scarlet fever may retain its virulence for some time, and be carried a long distance in various substances and articles in which it may have found lodgment. Do not permit a child to enter a privy or water-closet, or breathe the air from a privy, water-closet, cess-pool, or sewer, into which non-disinfected discharges from persons sick with scarlet fever have entered, nor to drink water or milk which has been exposed to such air."

(*D*) "Do not permit a child to ride in a closed carriage in which there has been a person sick with scarlet fever, unless the carriage has since been thoroughly disinfected with fumes of burning sulphur, etc."

(*E*) "During the prevalence of scarlet fever in epidemic form, avoid exposure to wind and to breathing cold, dry air; also the use of strong vinegar or any other substance which tends to make the throat raw and tender."

(*F*) "Do not wear or handle clothing worn by persons during their sickness or convalescence from scarlet fever."

(*G*) "Beware of any person who has a sore throat. Do not kiss such a person. Do not drink from the same cup, nor use any article that has been used by a person sick with this disease."

(*H*) "Beware of crowded assemblies in unventilated rooms."

(*I*) "Do not permit a child to drink water or take food which comes from a source that renders it liable to contain something derived from a person sick with scarlet fever."

In Ohio, as in most States, the law requires the attending physician to report the occurrence of any contagious disease, within twelve hours after the diagnosis is certain, to the board of health having jurisdiction over the territory in which such case is found. That all too frequently the lapse of time necessary to determine the specific nature of the attack admits of wide-spread exposure and contagion is the experience of every physician, and one can but emphasize again and again, with this fact in mind, the absolute necessity of treating every doubtful case as one of scarlatina. This is particularly applicable to those cases characterized by mild throat symptoms, or, as frequently happens, by the appearance of the eruption first upon the small of the back, as a transient efflorescence, associated with but slight constitutional symptoms,—a mild scarlatina,—but one capable of giving rise to the most severe type of the disease in a susceptible individual. In such cases, as has happened more than once to the writer, the attending physician, uncertain throughout the entire course of the attack as to its exact nature, may be regarded as "finnicky" and unjust, or his ability may be even for the moment questioned, until the appearance of typical desquamation absolutely confirms the diagnosis. It is almost certain that in these cases close quarantine will be heartily resented; but who can say what might not be the result were isolation not strictly enforced? In every case the responsibility of preventing any further spread of the contagion rests upon the attending physician. His duty to the community, to the family directly concerned, and to the patient, as well as to himself, demands that every precaution be taken to limit the spread of the disease.

With the development of symptoms in any way suggestive of scarlatina in a child or adult, the patient should be quarantined at once, shut off from communication with all but one or, at the most, two individuals (the child's mother and nurse), and carefully watched until a positive diagnosis can be made.

The diagnosis being certain, and, indeed, in all cases which continue doubtful for twenty-four hours, isolation should be rigorously enforced and continued until all possible danger of contagion is past. On the average, this may be said to cover a period of from six to eight weeks, and not infrequently longer. For this purpose a room should be chosen preferably at the top of the house, with, if possible, two win-

dows having a southern exposure and an open fire-place. Where available, the use of two rooms with a communicating door, or with doors closely adjoining on a common hall, is of the greatest advantage. This room should be stripped of all furnishings, excepting, of course, such articles as are essential to the proper comfort and care of the patient or of actual necessity to the nurse. The carpet should be taken up, old pieces of carpet, which can be destroyed later, being put down in its place; drapery and curtains must be removed; pictures, books, and all ornaments taken out; closets emptied; and, in short, nothing allowed to remain in the room which is not absolutely necessary for the proper conduct of the case, and which could possibly harbor the specific poison. The bedstead should preferably be of iron, with a woven wire mattress, the so-called hospital bed being the most advantageous, permitting the easy handling and care of the patient. The upper mattress should be of horse-hair, and of the common thickness; if too thin it is apt to become hard and uncomfortable. The bedding should be light, but of sufficient warmth, and only such should be used as can subsequently be boiled or destroyed. A flannel night-gown should be worn throughout the course of the disease. Handkerchiefs may be used when they can be destroyed. If this is not possible, gauze or old linen, cut into the required size, may be substituted, and, after being used, should be immediately burned. The sick-room should be further provided with a special set of dishes and utensils for the patient's use, which should not be allowed to go outside. A small gas-stove or kerosene-lamp should be added for the purpose of procuring boiling water, or for the actual preparation in the sick-room of such food as may be necessary.

The nurse in charge of the case should wear a uniform which can be thoroughly boiled, and should always, when in the sick-room, keep her hair covered by a suitable cap. Under no circumstances should she be allowed to come into contact, either direct or indirect, with the other members of the family.

The physician in daily attendance should put on a linen duster, or other special gown, before entering the sick-room, and still further protect his head by a skull-cap, and should come into actual contact with the patient as little as possible. Before leaving, he must thoroughly wash and disinfect his hands, spraying his hair, beard, and clothing with a 10-per-cent. solution of formalin. He should return to the open air as quickly as possible, and remain out-of-doors for an hour or more before seeing other children. That the contagion has

not infrequently been carried by a physician from house to house is well known, and that every means should be taken to prevent such an unhappy occurrence has been already insisted upon. That the danger is manifestly less when a complete change of clothing has been made must be admitted, but whether this can be carried out in every instance depends largely upon individual circumstances, and must be left to the physician to decide. That it is the safest method to prevent contagion is beyond dispute. Whenever there are children in the household they should, when possible, be sent away at once, and isolated until all danger of their carrying the poison is past. In any event they must be taken out of school at once, and kept out until sufficient time has elapsed to justify their safe return. The question as to whether the schools shall be closed during the prevalence of an epidemic of scarlatina is one of no little importance, and must be decided largely by the extent and severity of the prevailing epidemic. The method at present in vogue in so many of our large cities, of a regular inspection of the schools and school-children by specially detailed physicians, assures to the public the greatest degree of protection possible under the circumstances, and should in time show decided results in the lessening frequency of many contagious diseases.

With scarlet fever in a household, the adult members of the family should avoid society, and under no circumstances should the entrance of children into the house be allowed.

Personal Hygiene.—In the care of every case of scarlatina, no matter of how mild a type, the secretions from the nose should be removed by old linen or gauze handkerchiefs, which must be immediately burned; while the discharges from the throat and mouth, which in mild cases may be got rid of in the same way, should, in the severer forms, be received directly into a sputum-cup containing a strong disinfectant solution, such as carbolic acid, 1 to 40 in water (3 drachms to a pint) or a solution of chloride of lime of the strength of 4 ounces of the fresh chloride to a gallon of water. The fæces and urine should be disinfected by the chloride-of-lime solution or by strong carbolic-acid solution (6 ounces dissolved in 1 gallon of water), and, in the absence of sewer connection, should be buried at least one hundred feet from any well or running stream. When sewer connections are available, the urine and fæces may, after thorough disinfection, be emptied into the closet, which, in turn, should be thoroughly disinfected and flushed. All discharges from the ears should be received on soft pieces of cloth or gauze and at once destroyed.

All linen, towels, bedding, etc., should be thoroughly disinfected before taken out of the room, being at once placed, upon removal from the patient, in a solution of lime, prepared by diluting any given amount of the above solution with ten times the amount of water. If preferable, a solution of sulphate of zinc, 4 ounces; common salt, 2 ounces; and water, 1 gallon, may be substituted for the solution of lime; or the carbolic acid may be used. All linen should be left in the disinfectant solution at least two hours, and when finally taken from the sick-room should be boiled at once, and laundered separately.

A special set of dishes, glasses, and utensils should remain in the patient's room, but, if removed, should be placed first in the disinfectant solution and then be immediately boiled. All food and drink remaining unconsumed should be disinfected and destroyed. Food intended for the sick-room should be left outside the door, where it may be easily within reach of the nurse or attendant. In some instances a sheet kept moistened with a weak bichloride solution (5 per cent.) or weak carbolic-acid solution, may be hung outside the door as an added precaution. During the attack, and particularly throughout the stage of desquamation, especial attention should be given to the skin (see "General Management") in order to prevent any spread of the contagion by the desquamating epidermis.

After complete recovery, and at the expiration of the period of quarantine, a thorough bath should be given, clean clothing put on, and the child removed to an uninfected room.

The room recently occupied should be at once thoroughly disinfected. All bedding, linen, etc., should first be soaked in one of the disinfectant solutions for two hours or more, then removed and boiled. The room should then be subjected to a thorough fumigation, everything remaining being spread out so as to allow free access of the fumes. For this purpose sulphur may be used (5 pounds to a room), or, in preference, formaldehyde-gas. (See "Addendum"). After the room has remained closed for twenty-four hours it should be thrown open, admitting the ready entrance of air and sunlight for twelve hours. The furniture, utensils, bed, etc., may then be thoroughly washed with carbolic-acid solution (1 to 40). The mattress should be steamed and the walls cleaned with bread-crumb or one of the compositions sold for the purpose. The old pieces of carpet should, when possible, be destroyed; if this cannot be done they must be steamed. All the books, toys, etc., which have been in the sick-room and constantly handled by the patient during convalescence should be destroyed. The extraor-

dinary tenacity of the scarlatinal virus makes this the safest means of absolutely doing away with all danger of subsequent contagion from these sources.

When death occurs, the body should be wrapped in a cloth wrung out of a solution of sulphate of zinc, 8 ounces; common salt, 4 ounces; and water, 1 gallon. Burial should take place as soon after death as is possible, and should be private.

Management of the Disease.

General Hygiene.—The hygiene of the sick-room in scarlatina differs in no important principles from those involved in the conduct of any of the acute exanthemata. Provision for an abundance of fresh air and thorough ventilation cannot be emphasized too strongly. During the milder seasons of the year the windows can be kept sufficiently open to admit of a constant stream of outside air, while in winter, though it may not be possible to allow so long or constant an entrance of outside air, it must be insisted upon that the atmosphere of the sick-room be kept fresh, pure, and cool. With an open fire-place this is very much more easily accomplished. When two rooms with a communicating door are available the question of ventilation is much simpler, it being possible under these circumstances to keep a window constantly open in the adjoining room, without regard to weather, all draughts being controlled by the intermediate door. The temperature of the room should be kept between 65° and 70° F. (18° and 23° C.), and the bed so situated as to allow the freest admission of outside air, at the same time shielding the patient from any exposure to drafts, either directly or indirectly. When the room does not admit of this, screens may be used to further protect the patient, though their use should, if possible, be avoided. While screening the eyes from direct light, it is unnecessary to darken the room, as is so often done, except when light is actually complained of, the presence of a certain degree of daylight being of great hygienic value. The child should be kept in bed even in the mildest cases; the coverings should be as light as is possible, insuring protection against sudden changes in temperature, but not allowing too great warmth. How long the patient shall remain in bed must, in many instances, be decided by the individual case. As a general rule, it may be said that a child should be kept in bed for ten days after complete subsidence of the febrile stage. In this way only can the danger of late renal complication be avoided, while daily

examinations of the urine are our only guide as to just what changes may be taking place.

Throughout the course of the disease a tepid sponge-bath should be given twice a day. As a therapeutic agent in diminishing the tension of the skin and aiding in its eliminative functions such baths are of great service and, as a rule, extremely grateful to the patient. With the commencement of desquamation, and earlier, in those cases in which the eruption is associated with itching, the body should be carefully anointed from head to foot with cold cream, carbolized vaselin (2 per cent.), eucalyptus-oil, lanolin, or cacao-butter.

When vaselin alone proves too irritating, as it sometimes does in young children, it may be used with lanolin and olive-oil, as follows:—

℞ Olei olivæ .....3j (4.0).
Vaselini,
Lanolini.....aa q. s. ad ℥ij (60.0).
M. Signa: Apply locally.

The addition of menthol, as advised by Forchheimer, in from 1- to 2-per-cent. strength, will commonly give immediate relief in children when the itching is extreme. Carbolic acid may be added to the ointment in 2-per-cent. strength in place of menthol, as a mild antiseptic, though it must be admitted that it cannot have any marked antiseptic properties unless used in such strength as to endanger life.

Diet.—Throughout the first two weeks the diet in scarlatina should consist chiefly of liquids, while during convalescence it must be controlled largely by the age and general condition of the patient. In the febrile stage and well on into the second week milk, either alone or diluted with barley-water, should be given exclusively, and water should be allowed in abundance, either distilled or as soda-water or one of the aërated waters. By the end of the second week strained soup, beef-tea, mutton or chicken broth and junket may be added, and, as the general condition improves, the temperature remaining down and the urine normal, the diet may be gradually increased by the addition of oatmeal gruel, custard, lightly boiled eggs, and soft toast. Later, fish, baked potatoes, fowl, and finally meat may be allowed. In mild and uncomplicated cases ripe, fresh fruit may be given after the first week. As the essential objects in the diet of scarlatina are to supply sufficient nourishment for the maintenance of the patient, at the same time admitting of no unnecessary work on the part of the already overtaxed organism; and to aid, so far as possible, in the elimination of the

poison through the kidneys, so peculiarly susceptible to the scarlatinal virus, the absolute restriction during the early weeks to a milk diet, together with an abundance of water, is the safest and most rational plan. While perhaps, in a large series of cases, an absolute milk diet may not show any marked lessening in the frequency of nephritis, such limitation is certainly on the safe side. It is interesting to note, in this connection, the great diversity of opinion in reference to the all-important question of diet, many writers allowing, during the febrile course, soups, broths, and even eggs, in addition to milk; while other authorities insist upon an absolute milk diet. Moizard (*loc. cit.*, p. 158), following Jaccoud, attaches great importance to an absolute milk diet as producing the fewest intestinal toxins, at the same time being easy of digestion, and, above all, as aiding in diuresis.

In many cases of scarlatina the problem of feeding is most difficult. The greatly inflamed and often ulcerated condition of the throat renders swallowing extremely painful, and children, or even adults, will resent any attempt to give nourishment. In these cases one must give small and frequently repeated amounts of liquid food, such as beef-juice made from the fresh steak, egg-albumin, or some one of the meat-extracts. In rare instances it may be necessary to pass a nasal tube or to resort to rectal feeding. Constipation may be regulated by a mild aperient, as magnesia citrate, or by enema.

Medical Treatment.—As there is unfortunately no specific treatment for scarlatina, all endeavors to control the disease must rest, as heretofore, upon a purely symptomatic basis. With the discovery, isolation, and cultivation of the specific micro-organism, which it is to be hoped, in the light of recent work in this line, will eventually be realized, we may hope for some ultimate solution of the difficulties involving the treatment, not only of scarlatina, but all the acute exanthemata. In the experiments of Huber and Blumenthal[409] 13 cases of scarlet fever were treated by the injection of serum obtained from the blood of patients convalescent from the disease. Of these, 8 showed no marked results, in 3 an apparently pronounced and beneficial reaction was seen, while, of the remaining 2, 1 showed no reaction and 1 was thrown out because of other complications. In certain instances the use of antistreptococcic serum has given positive results,[410] while, again, in many cases no such results have followed its administration. Bagin-

[409] Huber and Blumenthal: Berliner klin. Woch., No. 31, 1897, pp. 671 *et seq.*

[410] See Jour. of the Amer. Med. Assoc., April 8, 1899. E. M. Landis reports a striking case of recovery following its use.

sky[411] has reported a series of 48 cases of scarlet fever, treated with Marmorek's antistreptococcic serum, of which 7 were fatal, or a mortality of 14.6 per cent. Theoretically, it should be of real value in all cases complicated by a streptococcic angina.

In all cases of scarlatina characterized by grave septic infection, and particularly in threatened uræmia, the subcutaneous injections of large amounts of sterile salt solution should, upon theoretical grounds at least, be of some value. In a few instances when thus used the writer has seen temporary relief in one case, and has urgently advised it, when not previously employed. Forchheimer (*loc. cit.*, p. 100) alone makes a strong plea for its more general use, even suggesting the direct transfusion into a vein, or injection into the serous cavities of sterile normal salt solution, with the object of diluting the poison circulating in the blood, and as a mechanical aid to diuresis and the elimination of toxins. The positive and beneficial results of this method in conditions closely analogous to those arising in scarlet fever justify us in believing that in certain cases of scarlatina much might be gained by such measures if adopted promptly. In the great majority of cases with slight angina, but little fever, and mild constitutional symptoms, isolation, rest in bed, diet, and nursing, together with the local care of the pharynx, the administration of a diuretic mixture, the proper care of the skin, constitute all the treatment necessary. It must not be forgotten, however, that serious complications may arise at any time, even in the mildest case, and that one should be continually on guard against any such possible contingency.

The Throat.—The care of the pharynx in every case of scarlatina, however mild, is of the first importance. In adults and children old enough to gargle the use of some mild antiseptic solution every two or three hours during the acute stage of the angina should be insisted upon, while in the very young a spray must be resorted to. For this purpose a saturated solution of boric acid; a 1-per-cent. solution of carbolic acid in lime-water; dilute peroxide of hydrogen, or the lotion given at the end of the volume may be used. In addition, as a means of local relief, small pieces of cracked ice may be held in the mouth, while for the enlargement and tenderness of the lymphatic glands an ice-bag or cold compresses must be applied. In cases in which the repeated use of a spray is resented by young children, a teaspoonful of a 0.5- to 1.5-per-cent. solution of salicylate of soda may be given every hour or two, as advised by Forchheimer (*loc. cit.*, p. 94).

[411] Baginsky (A.): Berliner klin. Woch., 1896, No. 33, pp. 340 *et seq.*

In cases characterized by a severe angina, with excessive secretion and accumulation in the throat, a spray should be used regularly in addition to the gargle, and often irrigation of the pharynx with hot water to which glycerin has been added, a drachm to the quart, affords great relief to the choking sensation so frequently present at this time.

Fever.—The use of antipyretic drugs for controlling the fever in scarlatina has almost entirely given place to hydrotherapy, though in certain cases they may still be found of some value. Osler (*loc. cit.*, p. 80) says of them: "Medicinal antipyretics are not of much service in comparison with cold water." If used, quinine and phenacetin are to be preferred. When drowsiness, restlessness, or delirium supervene, Henoch (*loc. cit.*, p. 684) advises, in addition to a tepid bath, the use of a single dose of either quinine, gr. vii-xv (0.5 to 1 gramme), or phenacetin, gr. iv-viij (0.25 to 0.5 gramme), between five and six in the afternoon. Ashby (*loc. cit.*, p. 271) recommends the use of quinine in 1 to 3 grain (0.065 to 0.2 gramme) doses, together with cold packs in those cases in which the temperature continues high. Phenacetin may be used in the same way in doses of $^1/_4$ to 1 grain (0.016 to 0.065 gramme), repeated as may be necessary. Antipyrin and antifebrin are, as a rule, too depressing, and not to be recommended. There exists to-day an almost unanimous opinion as to the value of cold water, in one form or another, as the safest and most reliable means we have for reducing the temperature in scarlatina. Whether it be in the form of cold spongings, cold packs, or the cold bath, each of which may be applied to meet the varying needs of the individual case, there is no better means of controlling, not only the fever, but also of influencing the grave nervous symptoms often accompanying it. Moizard (*loc. cit.*, p. 160) truly says: "Here, as in typhoid fever, cold water is of the greatest service; not only does it lower the temperature, but quiets the nervous excitement, inducing almost always a more or less prolonged sleep; and, above all, it aids in diuresis. The action on the pulse is equally manifest: in infants it may fall from 180 to 150. The diarrhœa and vomiting, so frequent in the grave forms, is lessened or even ceases under the action of the cold bath. The action of cold water from all these points of view is marvelous." According to the above author, Currie was the first to employ cold in scarlet fever, so long ago as 1798, in the form of cold affusions. Von Jürgensen (*loc. cit.*, p. 238) considers the use of cool baths the best means of controlling scarlatina from its invasion until the disappearance of all severe symptoms; bathing whenever the rectal temperature reaches 104° F. (40° C.), the

temperature of the bath for young children being 68° F. (20° C.) and its duration but five minutes. With older children and adults the temperature of the water is 59° F. (15° C.), and the bath is prolonged from five to fifteen minutes. Henoch (*loc. cit.*, p. 684), on the other hand, while advising against the cold bath as tending to produce collapse, which opinion is shared by Jacobi[412] in this country, heartily indorses the use of cold sponges and cold packs. The application of the cold bath at the temperature advised by von Jürgensen might readily, for many reasons, prove impracticable, and the writer has seen quite as satisfactory results follow a bath given at a temperature of 10° or even 15° higher.

In severe cases with marked cerebral symptoms and a rapidly rising and persistent temperature of 103° to 105° F. (39.5° to 40.5° C.), in addition to the cold pack, which frequently serves every purpose, a cold bath may be given, the temperature at the outset being 80° F. (26.6° C.) or even higher. It is then gradually reduced to the desired point. Given in this way, there is generally less opposition on the part of the family, while the results are almost, if not equally, satisfactory. Cases characterized by extreme restlessness, marked delirium, and convulsions yield, as a rule, more readily to an extremely hot bath, at a temperature ranging from 105° to 110° F. (40.5° to 43.3° C.), while with grave cerebral disturbance, as shown by drowsiness, stupor, and even coma, the patient may be placed in a tepid bath and cold water poured directly upon the head for from five to ten minutes, as advised by Steffen.[413] An ice-cap or cloths wrung out of iced water may be used throughout the course of the disease when the temperature is high.

As contra-indications to the use of the cold bath in scarlatina, von Jürgensen[414] gives the following:—

"All demonstrable anatomical, and especially inflammatory, changes in the heart; all evidences of dyspnœa associated with narrowing of the upper respiratory tract; hæmorrhages from the nose, throat, eroded blood-vessels, or in the hæmorrhagic diathesis; and all inflammations involving the joints."

General Indications.

In mild cases of scarlet fever the treatment above outlined will generally suffice. With moderate fever, good pulse, and without gas-

[412] Jacobi (A.): "Therapeutics of Infancy and Childhood" (Philadelphia, 1898), p. 237.

[413] Steffen (*loc. cit.*, p. 231).

[414] Von Jürgensen (*loc. cit.*, pp. 243 *et seq.*).

tric irritability after an initial dose of calomel, the tincture of the chloride of iron may be given, either alone or with dilute hydrochloric acid as follows:—

℞ Tinct. ferri chloridi.....f℥ij (7.0).
Acidi hydrochlorici diluti.....f℥j (3.5).
Syr. limonis .....f℥j (30.0).
Aquæ .....q. s. ad f℥iij (90.0).

M. Signa: Teaspoonful every two or three hours.

Or, as recommended by Yeo[415]:—

℞ Liq. ammoniæ acetatis.....f℥iss (37.5).
Potass. chlorati .....f℥j (3.5).
Syr. limonis .....f℥ss (15.0).
Aquæ .....q. s. ad f℥vj (170.0).

Misce et fiat mistura.

Signa: One to three teaspoonfuls every four or five hours, according to age.

Tincture of aconite may be added in $^1/_2$ minim doses to the above, in cases characterized by a rapid, hard pulse, but should be omitted after forty-eight hours. Moizard (*loc. cit.*, p. 156) gives a solution of ammonium acetate, as a rule, during the first days, omitting it when the rash is fully developed.

Although in many instances simple uncomplicated scarlatina may be carried to a successful termination without the need of stimulation, indications may demand it at any time during the course of the disease, and are to be found, as in all acute infections, in the character of the heart's action and the pulse. The moment the first sound of the heart becomes weak, or the two sounds lose their normal tone, and any threatening change is noted in the pulse, stimulation must be insisted upon. For this purpose brandy or whisky in suitable doses may be given and repeated when necessary. If objectionable, champagne, with an abundance of finely cracked ice, is often grateful, and answers the purpose, at least temporarily, equally well. Strychnine may be given every three or four hours: $^1/_{100}$ grain (0.00065 gramme) to a child of three three times a day. When the pulse is weak, soft, and of low tension Holt (*loc. cit.*) advises the use of digitalis.

With the appearance of grave symptoms of a septic or toxic character, high fever; a small, weak, rapid, or even irregular pulse; cyanosis; cold extremities, and threatened collapse, the question of stimu-

[415] Yeo (I. B.): "Manual of Treatment" (Philadelphia, 1893), vol. ii, p. 605.

lation becomes at once of the first importance. Brandy or whisky may be given in teaspoonful doses as often as necessary, and in addition 5 to 15 minims of aromatic spirit of ammonia, alone or with equal parts of ether in strong camphor-water, may be given hourly. Henoch (*loc. cit.*, p. 685) considers camphor of the greatest value in this condition, giving $^1/_2$ to 3 grains (0.032 to 0.2 gramme) every two or three hours hypodermically, or in solution with ether (camphor, 1; in ether, 10). Musk, in doses of $^1/_2$ to 3 grains (0.032 to 0.2 gramme), may be given every two hours. When collapse is imminent, Moizard (*loc. cit.*, p. 161) advises caffeine in doses of $^3/_4$ to 1 $^1/_2$ grains (0.05 to 0.1 gramme), or the sulphate of sparteine in distilled water in doses of $^1/_3$ grain (0.02 gramme) or more, hypodermically; while with grave toxic symptoms and a low temperature, Jacobi (*loc. cit.*, p. 237) recommends morphine in doses of $^1/_{50}$ to $^1/_{20}$ grain (0.0013 to 0.0032 gramme), to be repeated as necessary. For cardiac dilatation digitalis or strophanthus may be used, as seems best.

When restlessness and active delirium cannot be controlled by means of hydrotherapy, bromide of potassium or chloral-hydrate, in addition to the hot bath, may be given. When it is impossible to give the hot bath, a hot pack may be substituted. In rare cases local depletion by leeches may be of the greatest value, and in one case at least the writer is confident that a fatal issue was thus prevented.

Treatment of the Complications.

Angina.—In septic cases with excessive involvement of the pharynx, associated with active inflammation, ulceration, or the development of a false membrane, active measures must be employed to prevent the extension of the local process. An ice-bag or iced cloths should be kept constantly applied over the throat and neck, while the pharynx and mouth should be carefully sprayed, and thoroughly washed out every two or three hours with a strong antiseptic solution. For this purpose hydrogen peroxide (2 to 3 per cent.); potassium permanganate, 15 grains to 1 ounce of water (1 gramme to 30 cubic centimetres); or a solution of chlorate of potassium of the same strength may be used.

A strong acid solution of chlorine-water is heartily indorsed by many English writers.[416] This is prepared by adding strong hydrochloric acid to powdered potassium chlorate in a large bottle filled with

[416] See Ashby, Calger, Moore, and Yeo (*loc. cit.*).

water, carefully stoppered, and then thoroughly shaken; the proportions being: strong hydrochloric acid, 5 minims; powdered potassium chlorate, 9 grains; and water, 1 ounce (HCl, 0.30 cubic centimetre; potass. chlor., 0.6 gramme; water, 30 cubic centimetres). In all cases of membranous pharyngitis Jacobi (*loc. cit.*, p. 260) recommends the internal administration of potassium chlorate, adding, at the same time, a warning against too large doses. Not more than 15 grains (1 gramme) should be given in twenty-four hours in divided doses, every hour or two, to a child of one year.

When the membrane shows the slightest tendency to spread beyond the tonsils, a bacteriological examination should, if possible, be made, and, if Klebs-Loeffler bacilli are found, diphtheria antitoxin should be given at once, as in a true diphtheria. When not found, and the membranous inflammation is of pure streptococcic origin, antistreptococcic serum may be used with the hope of limiting the process. If uncertainty exist and a bacteriological examination be not available, the administration of the antistreptococcic serum in the early membranous angina of scarlatina is at least a rational plan and can do no harm. When the local process extends to the posterior nares and is accompanied by a profuse coryza, with acrid, irritating discharges, the nostrils must be thoroughly irrigated with a mild antiseptic solution, as dilute peroxide of hydrogen or dilute chlorine-water, care being taken that the solution be not too strong and irritating. Henoch[417] advises the use of a 1-per-cent. carbolic-acid solution in these cases.

In the event of grave ulcerative or gangrenous inflammation of the tonsils Heubner[418] advises direct injection of a 3- to 5-per-cent. carbolic-acid solution into the tonsillar substance. At the Children's Hospital in Vienna this has been followed, in some instances, by necrosis, and is regarded as of doubtful value.[419] In these cases a 5-per-cent. solution of carbolic acid in glycerin or a saturated solution of salicylic acid in alcohol may be applied locally. The use of the actual cautery, though advised as a last resort, may be difficult and even impossible. The occurrence of suppuration, and, rarely, of a retropharyngeal abscess, demands free incision.

Diphtheria.—Diphtheria complicating the late stage of scarlatina should be treated as such by the administration of antitoxin in large amount, and the local application, every four hours, of Loeffler's solu-

[417] Henoch (E.): "Charité Annalen" (*loc. cit.*, p. 562).
[418] Heubner: See Henoch (Vor., *loc. cit.*, p. 686).
[419] Writer's personal notes.

tion,[420] by the application of ice-bags, and by stimulation as may be indicated.

Involvement of the Lymphatics.—The enlargement and tenderness of the lymphatic glands in the neck should be treated by the application of cold, in the form of ice-bags or iced cloths, and when glandular inflammation persists cold applications should be continued for twenty-four to forty-eight hours. If the enlargement increases, poultices may be resorted to, and the moment fluctuation is made out the gland should be freely incised and the pus evacuated; then thoroughly irrigated and dressed antiseptically. With the rare occurrence of a general cellular infiltration and cellulitis, characterized by tense induration of the deeper tissues of the neck,—the so-called "angina Ludovici,"—it is frequently wiser not to delay until suppuration occurs, but to relieve the condition at once by free incision. Forchheimer (*loc. cit.*, p. 195) indorses painting over the inflamed gland with flexible collodion as a means of preventing absorption from the superficial lymphatics; and has never seen a case of angina Ludovici when this method had been employed.

Otitis. — The occurrence of otitis media in scarlet fever often first becomes evident by the escape of pus from the external auditory canal, that early interference on the part of the physician is frustrated, and the treatment resolves itself into the subsequent care of the ear. Too great emphasis cannot be placed upon the value of thorough irrigations of the fauces, in every case of scarlatina, as a means of preventing the extension of the inflammatory process to the middle ear. This is naturally not always easy, and repeated spraying, if bitterly resented, may, when forced, result in more harm than good.

The occurrence of earache, however slight, or of pain referred to either ear, should be closely watched for. For the early earache the instillation of simple salt solution or water, as hot as can be borne, may give great relief. A small thin bag, which is easily and quickly made, may be filled with common salt, and applied as hot as can be tolerated. If no relief follow, a few drops of a warm solution of cocaine (3 to 5 per cent.) may be dropped into the canal. This serves a double purpose: relieving the pain and at the same time allowing a freer examination of the ear with a speculum. As soon as any evidence of the presence of pus appears, as shown by the opacity and bulging of

[420] Menthol, gr. cl (10 grammes); dissolved in toluol to f℥if℥i*m*xl (36 cubic centimetres); liquor ferri sesquichlor., f℥i*m*vlij (4 cubic centimetres); and absolute alcohol, f℥ij (60 cubic centimetres).

the membrane, it should be incised, and the ear irrigated two or three times daily with a warm solution of equal parts of hydrogen peroxide and boiled water, being protected externally by large compresses of sterile gauze. If the membrane close prematurely, the incision should be repeated. No danger can result from repeated incisions, and the ready escape of all pus as it accumulates is of vital importance. When the discharge persists throughout convalescence, and tends to become chronic, the irrigations must be continued at least twice daily. The hydrogen peroxide may be replaced by carbolic acid (2 to 3 per cent.), by lysol (1 to 2 per cent.), or resorcin (2 to 3 per cent.). Later insufflations of finely powdered boric acid once or twice a day may be used, always irrigating the ear thoroughly before each insufflation.[421]

Nephritis.—Although, in rare instances, renal complications may arise, of which the urinary examination gives no warning, our knowledge of such changes depends absolutely upon daily examinations, both chemical and microscopical, together with an accurate record of the amount passed during each twenty-four hours. With the first evidence of renal inflammation, every endeavor should be made to aid in the eliminative functions of the skin and bowels, to relieve the kidneys of all unnecessary work, and to lower the blood-pressure.

The child must be kept in bed, and the diet should be exclusively of milk. Water may be given freely and lemonade is allowable.

The action of the skin is aided by hot baths or packs. In the former the child is usually placed in a bath at a temperature ranging from 100° F. (37.8° C.) to 110° F. (43.3° C.) and allowed to remain for ten to fifteen minutes, during which the surface of the body is gently rubbed. He is then taken out and placed between blankets without being dried, in which he is left for an hour. After this the body is thoroughly dried, and the child placed in a warm bed. In giving the hot pack the child is wrapped in a blanket wrung out of hot water at 100° F. (37.8° C.) and then covered by a dry blanket, over which is placed a rubber cloth. This may be repeated as often as necessary.

Under some circumstances the hot-*air* bath proves more efficient, and may be given as follows: The patient is covered with a blanket, while on either side hot flat irons or hot bricks are placed so protected as to prevent any possible danger of a burn. A mackintosh is then placed over these, and over all a second blanket. Sweating can usually

[421] Politzer (A.): "Lehrbuch der Ohrenheilkunde" (Stuttgart, 1893), pp. 351-353.

be quickly induced by this method, and is often profuse. The use of the ordinary flat iron may appear crude, but they are commonly available in every household, and the writer has seen them used in this way with great success in threatened uræmia.

Pilocarpine may be given hypodermically in doses of $^1/_{30}$ to $^1/_{16}$ grain (0.0022 to 0.004 gramme) to children from two to ten years of age, but great caution should be used in its administration, and, when marked bronchial secretion exists, it is safer to omit it.

After a dose of calomel the bowels may be kept open by a mild saline purge, such as citrate of magnesia.

When uræmia threatens, free catharsis should be induced at once, followed by the hot bath, pack, or the hot-air bath. In addition, pilocarpine may be given, while nitroglycerin, if indicated, may be used to lower the blood-pressure, and, if nervous symptoms—such as slight or marked twitchings or actual convulsions—develop, chloroform may be administered or chloral and opium given internally. Local bleeding by leeches or venesection may often be successfully resorted to. With the existence of marked dropsy and general anasarca, the danger of possible effusion into the serous cavities of the body must be borne in mind, and should, when possible, be relieved by aspiration. Digitalis or strophanthus may be given as a diuretic. For the subsequent anæmia common in nephritis iron in some form should be given. In all cases complicated by nephritis the return to the normal diet should be slow and guarded.

Arthritis.—If the acute synovitis or arthritis of scarlatina is the result of a streptococcic infection, as is commonly held to-day, it should obviously be treated as such, and not as rheumatism. In mild cases belladonna and chloroform liniment may be used. In more severe forms the joints involved should be protected with cotton-wool and bandaged. If the symptoms are intense and persistent, antistreptococcic serum may be tried. Though not yielding as readily as true rheumatism to the salicylates, they may be given in the form of salicylic acid or the salicylate of soda. With the occurrence of suppuration the joint must be opened. Tenosynovitis may be treated locally by cold applications, and true articular rheumatism should, of course, be treated as such.

Endocarditis or Pericarditis.—Throughout the course of the disease the heart demands most careful watching, and particularly is this true when, even in the absence of other grave symptoms, any synovial or articular inflammation is present. The danger of endocarditis or

pericarditis in these cases must not be forgotten. They must be treated by the application of ice-bags over the heart, by the use of digitalis, and such other stimulation as may be necessary. With pericarditis the danger of possible effusion into the pericardial sac, sometimes demanding paracentesis, is to be remembered.

Bronchitis, Pneumonia, and Pleurisy.—Complications on the part of the respiratory system—as severe bronchitis, pneumonia, or pleurisy—are to be treated as when occurring under other circumstances. The frequency with which the inflammatory pleural exudate in scarlatina becomes purulent has been noted. This danger must be carefully looked for, and, if present, immediate resection of a rib and evacuation must be insisted upon.

Stomatitis.—As a rule, nothing more is required in the way of local treatment of the mouth than has been already outlined. Thorough asepsis is the best prophylactic against stomatitis. In severe cases characterized by rapidly ulcerating and sloughing surfaces local applications may be made with a 10-per-cent. solution of silver nitrate or a 1-to-500 solution of the bichloride of mercury, though the latter cannot be used without danger in children. If necessary, the part may be curetted, or the actual cautery applied under an anæsthetic.

Gastro-enteritis.—The presence of marked gastric irritability, with excessive vomiting, may seriously complicate the treatment of scarlatina. Although frequently obstinate, it may be relieved by small doses of calomel, $^1/_{12}$ grain (0.0054 gramme); bismuth subnitrate, 5 to 10 grains (0.32 to 0.65 gramme); or bicarbonate of soda in the same doses, repeated every hour or two. When persistent, opium may be tried in doses of $^1/_{60}$ to $^1/_{150}$ grain (0.001 to 0.00043 gramme) given every two hours or oftener; or the muriate of cocaine in doses of $^1/_{20}$ to $^1/_{50}$ grain (0.0032 to 0.0013 gramme) may be used. All nourishment must be withheld for a number of hours, albumin-water being given when necessary. Normal feeding must be very slowly resumed, small amounts at frequent intervals being allowed until that time.

Diarrhœa occurring early in the disease frequently subsides during the first few days, and should be let alone. If persistent or occurring later in the course of the attack, it should be controlled by bismuth subnitrate given with salol, the deodorized tincture of opium, or starch-water and laudanum enemata.

EDWARD PERKINS CARTER.

CHAPTER VI.

RUBEOLA.

(Measles,[422] Morbilli[423]; French, *rougéole*; German, *masern, flecken*; Italian, *morbilli, rosolia*; Spanish, *serampión.*)

DEFINITION.

MEASLES is an acute, eruptive, febrile disorder, usually occurring in childhood or early adolescence, and is caused by a specific contagium. It is characterized by coryza or a congestive disturbance of the upper air-passages, conjunctivæ, etc., together with a distinctive macular or phlyctenular eruption, which is accompanied by a considerable elevation of temperature. It is both infectious and contagious, and immunity is usually conferred by one attack.

Measles presents less variability than both variola and scarlatina, although its conspicuous features are by no means uniform. Sydenham, in conformity with the teaching of the seventeenth century, regarded the fever as the cardinal symptom, while Hebra places this disease among the acute, exudative, contagious dermatoses. We of the present look upon measles as the result of a specific living contagium, which, gaining access to a susceptible organism, gives rise to a regular sequence of symptoms, liable to some variation according to individual peculiarities and conditions of environment or general sanitation. Hence, such terms as "black measles," "camp measles," "false measles," etc., commonly employed by the laity and sometimes by medical men to designate hæmorrhagic or other unusual clinical forms, while they may have no definite, scientific meaning, usually indicate some aberration or departure from the normal, and as such will receive further consideration in the text. The normal, or ordinary, form, of moderate severity, constitutes the type, and will first receive attention, after which the less frequent and anomalous forms will conclude the description.

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[422] Derived from an old English word meaning a spot, probably derived from the German *masern*, spots, which, in turn, may be derived from the Sanskrit *masura*, spots.

[423] For derivation see page 17.

RUBEOLA VULGARIS (*Morbilli Regulares*).

SYMPTOMATOLOGY.

Regular, or Normal, Course.

For clearness of description the symptoms of measles may best be studied under groups, denominated periods, or stages, of which there are four. The line of demarkation between them is not clearly drawn, and in the first, or prodromal, stage no special symptoms are usually present, yet the *ensemble* is sufficiently distinctive in each stage to warrant a separate description.

Period of Incubation. — After exposure to measles a certain time elapses before any evidence of the disease appears. This is called the period of incubation, or latent stage, and ranges from 9 to 14 days, most frequently 11 days. In 144 cases Holt[424] found the period of incubation in 66 per cent. to be from 11 to 14 days. That this is subject to great variability may be seen from the following table taken from his work:—

Incubation	less than	9	days,	3	cases.
"	from	9	to	10	"	22	"
"	"	11	"	14	"	95	"
"	"	15	"	17	"	19	"
"	"	18	"	22	"	5	"

In 60 cases observed by Haig Brown,[425] at the Charter-House School the period was 14 days. On the other hand, cases have been recorded in which only 5 days have elapsed between exposure and the first appearance of the disease. When measles occurs a second time, the stage of incubation is said by Graham[426] to be from 18 to 21 days, and, when inoculated, to be much shorter, ranging from 8 to 10 days. We have reason to believe, however, that the poison is not wholly inactive, even from the moment of reception, and not infrequently some slight constitutional disturbances are complained of a day or two before the advent of the more distinctive evidences of infection. In determining quarantine regulations these extremes must be taken into account.

ACTUAL ATTACK.

Prodromal Stage (*Stadium Prodromorum*), or Period of Invasion.—The first symptoms are those of an ordinary coryza, with a

[424] Holt: "Diseases of Infancy and Childhood" (New York, 1899), p. 911.

[425] Brown: Brit. Med. Jour., April 16, 1887, p. 826.

[426] Graham: Article on "Measles," Morrow's "System of Dermatology," etc. (1894), vol. iii.

tory lesions, and their diagnostic significance has recently been emphasized by Filatow,[431] Canby,[432] and Koplik.[433]

Like most acute exanthematous affections, the mucous surfaces in measles present the first visible changes (enanthem). This is accounted for by the more delicate structure of the parts, as will elsewhere be shown, and the absence of a thick, horny epidemic covering, which masks the first pathological manifestations in the skin (exanthem). For this reason the former may be studied at an earlier period, and, as previously stated, as early as the second day after the appearance of constitutional symptoms. Even in 1806 Willan[434] observed, on the fourth day of the fever, small, dark-red spots on the palate, uvula, and tonsils, which on the fifth day merged, forming a bright-red surface extending backward to the fauces. In 1812 Heim[435] distinguished between the enanthem and exanthem of measles. "Usually there appears in the mouth on the second day of the fever small, bright-red spots (*Kleine hellrothe Flecke*)," which he regarded as identical with those which later appeared on the skin. In Dunglison's "Cyclopædia of Practical Medicine"[436] (1854), in describing the eruption of measles Forbes states that the eruption spreads over the face; spots also may be observed on the palate and fauces. Trousseau in 1866 (*loc. cit.*, p. 171) clearly described the early appearance of the buccal lesions and their relation to the subsequent cutaneous exanthem. "Before there is any exanthem on the skin you see the disease inscribed on the pharynx, tonsils, and veil of the palate." Niemeyer[437] mentions that Rehn observed an eruption of pale-red, rather undefined spots on the mucous membrane of the cheeks, gums, lips, and fauces. In addition to these von Jürgensen (*loc. cit.*, p. 89) mentions Franz Mayr (1852), Ziemssen and Krabler (1861), Barthez and Rilliet (1854), and especially Monti (1873), as having given particular attention to the prodromal enanthem of measles. He further quotes at length from Flindt,

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[431] Filatow: "Acute Infectionskrankheiten," 1895, S. 349.

[432] Canby: "Notes sur l'énanthème buccal de la rougéole; stomatite erythemato-pultacée accompagnant l'eruption." Bull et Mém. Soc. Med. de l'Hôp. de Paris, 1895, 3. S., xii, 760-762.

[433] Koplik: Archives of Ped. (New York, December, 1896), and Med. Record (New York, 1898), liii, 505-507.

[434] Willan (Robert): "Diseases of the Skin" (London, 1808).

[435] Heim: Bemerkungen über die Verschiedenheit des Scharlachs, der Rötheln, und der Masern, u. s. w." Journal der praktischen Heilkunde, C. W. Hufeland und K. Hunley, herausgeber (1812), Stück iv, S. 86.

[436] Dunglison: "Cyclopædia of Practical Medicine" (1854), vol. iv, p. 53.

[437] Niemeyer: "Practice of Medicine" (1876), vol. ii, p. 528.

PLATE XXXIV.

Fig. 1.

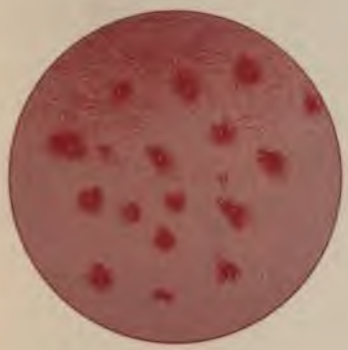


Fig. 2.

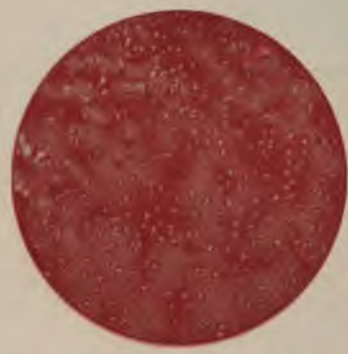
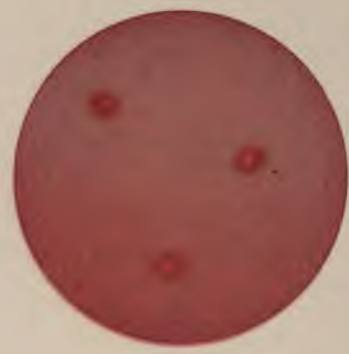


Fig. 3.

Fig. 4.



THE ENANTHEM, OR THE SO-CALLED PATHOGNOMONIC SIGN OF MEASLES

FIG. 1.—The discrete measles spots on the buccal or labial mucous membrane, showing the isolated rose-red spot, with the minute bluish-white centre, on the skim-milk colored mucous membrane.

FIG. 2.—Shows the partially diffuse eruption on the mucous membrane of the cheeks and lips; patches of pale pink interspersed among rose-red patches, the latter showing numerous pale bluish-white spots.

FIG. 3.—The appearance of the buccal or labial mucous membrane when the measles spots completely coalesce and give a diffuse redness, with the myriads of bluish-white specks. The exanthema on the skin is at this time generally fully developed.

FIG. 4.—Aphthous stomatitis apt to be mistaken for measles spots. Mucous membrane normal in color. Minute *yellow points* are surrounded by a red area. Always discrete.

(Through the courtesy of Dr. Henry Koplik, Med. News.)

of Denmark, who in the *Sundheds-collegium*, 1880, gives a clear account of its appearance and course as follows:—

"First day of the fever: A slight, diffuse erythema of the throat.

"Second day of the fever: A fairly dark redness without marked œdema of posterior pharyngo-palatine arch and tonsils, which, on the anterior palatine arch (arcus glosso-palatinus) and velum palati, is somewhat less deep in color and of an irregularly diffused or mottled appearance. On the evening of the second day of the fever the mucous surfaces of the tonsils, and the posterior palatine arch, have undergone but little or no change, appearing as a uniformly red erythema, with slight œdema. On the anterior surface of the soft palate, and the posterior part of the hard palate, as well as occasionally on the remaining normal mucous surfaces, a distinct exanthem appears. The lesions are round or irregular in shape, of a bright-red color, having an ill-defined margin, with little or no elevation at this time above the surrounding surface. They range from a pin-head to a lentil in size, and occur singly, or are scattered irregularly over the surface. In places there is a tendency for the lesions to cluster in groups and to become blended.

"They acquire a peculiar appearance on account of numerous small, white, glistening points (simulating minute vesicles), which occupy the middle of the small, red macules. These manifestations in the macules are irregularly grouped. One can see and feel the minute vesicles elevated above the surrounding areas. The palpebral conjunctiva is hyperæmic in its entire extent. Besides the reticular and macular reddening of the conjunctiva, which is due to the disposition of the conjunctival vessels, there are also small, glistening, miliary elevations similar to the elevations in the palate.

"Third day of the fever: The mucous surfaces of the buccal cavity, which, up to this time, have been only slightly hyperæmic, are now found to be invaded by the lesions previously described. These latter are strongly marked over the entire anterior surface of the velum palati, the glosso-palatine arch, and usually also over the contiguous two-thirds of the hard palate. The red spots are sometimes very numerous, at other times isolated, and again, by blending, they form irregular figures of a stronger red than previously seen. Here and there a faint appearance of the previously described vesicle-like formations is seen projecting above the surrounding surface. On the other hand, they may also be found on the apparently normal mucous membrane. Similarly grouped spots with whitish vesicles now also appear

on the inner surface of the cheeks, especially on the part opposite the juxtaposition of the upper and lower molar teeth.

"As a rule, the gums and the inner surface of the lips retain their normal color, or at most are only slightly hyperæmic. It is, indeed, seldom that the eruption appears on these parts. The tonsils and both pharyngo-palatine arches still remain red.

"The palpebral conjunctiva retains its deep-red color, but no spots are visible, excepting the minute vesicles previously described. At this time the eruption breaks forth on the skin. On the evening of the third day there is little or no change perceptible.

"Fourth day of the fever: On the palate and inner surface of the cheeks the spots stand out prominently, while in many places there is a tendency to merge by enlargement of the individual lesions, and on the surfaces last invaded they are more copious than ever. The conjunctival exanthem is now disappearing. On the evening of this day there is no change noted.

"Fifth day of the fever: The exanthem in the buccal cavity is more marked than heretofore. Frequently at this time there appear faint-reddish spots on the mucous surfaces of the lips, even extending to the exposed cutaneous margin. On the gums they are seldom present and never distinct. The hyperæmia of the posterior fauces remains unchanged.

"The skin exanthem begins to fade, and the temperature falls.

"Sixth day of the fever: The exanthem on the mucous surfaces is no longer visible, except a slight diffuse redness of the palate and the inner surface of the cheeks. Fever ends."

This characteristic enanthem is seldom absent. Slawyk[438] found it present in 90 per cent. of all cases examined.

Another symptom described by Bolognini,[439] which he considers pathognomonic of measles, consists of a fine peritoneal crepitation, or friction, "as if two bottles were rubbed together," when the pulps of the fingers are applied with gentle pressure to the relaxed abdomen. Bolognini describes the method as follows: The patient is placed on his back, with the legs flexed and the abdominal muscle relaxed. The pulps of the three middle fingers of both hands are applied to the abdomen and gentle pressure, gradually increased, is made with a kneading movement, when a slight rubbing sensation will be conveyed

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[438] Slawyk: Deut. med. Woch., April 28, 1898.

[439] Bolognini: "Jahresbericht über die Leistungen und Fortschritte in der Gesammten Medicin," 1898.

to the fingers, which disappears as the pressure is increased. Bolognini found this symptom absent in the prodromal stage only twice in two hundred cases. It usually ceased with the appearance of the cutaneous eruption. He regards it as due to vascular disturbances of the peritoneum, analogous to the enanthem as observed on the mucous surfaces. Köppen[440] found this sign in 50 per cent. of all cases examined. Little diagnostic significance can be attached to it, however, as it is now known to be found in other affections.

The duration of the prodromal stage, or stage of development, is from three to five days, most frequently four days. In rare instances this is said by Trousseau and others to be prolonged to the sixth or even the tenth day. In 270 cases Holt (*loc. cit.*) found the stage of invasion—that is, from the beginning of the catarrh to the eruption—to be:—

1	day or less	in 35	cases.
2	days	" 47	"
3	"	" 64	"
4	"	" 64	"
5	"	" 29	"
6	"	" 20	"
7	"	" 6	"
8	"	" 2	"
9	"	" 2	"
10	"	" 1	case.

Most of these were under three years of age. In adults less variability is observed, although Roger[441] found the period of invasion shorter than in children over two years old, and longer than in infants.

Period of Efflorescence (*Stadium Exanthematicum vel Floritionis*), or Eruptive Stage.—The eruption is usually first noticed on the morning of the fourth day. On the evening preceding, if careful inspection be made, a faint mottling or roughened condition of the skin may be detected. Less frequently it comes out on the third or fifth day. The first lesions appear on the upper part of the forehead, on the temples, behind the ears, and on the sides of the neck. In most cases one or the other of these positions is first involved, although, and more frequently, the eruption appears simultaneously in one or more of them. It soon appears about the eyes, mouth, and on the chin. At first the lesions are few in number, of a small, punctate appearance, dark reddish in color, presenting a clinical picture not unlike that pro-

[440] Köppen: *Ibid.*

[441] Roger (H.): Rev. de Méd., April, 1900, p. 290.

duced by fleas and other insects. With the appearance of the exanthem on the skin the constitutional disturbances increase in severity, the catarrhal symptoms are aggravated, the cough is more troublesome, inspiratory stridor may be heard, and deglutition is not infrequently more painful. The patient feels as if his eyes were filled with sand, and they are so sensitive to light that some difficulty may even be experienced in obtaining a clear view of the eruption on the face. It is quite characteristic to find the patient with his face buried among the pillows, or to hear him ask that the shades be drawn. The temperature at this time is observed to be rising, with slight morning remissions, increasing from $^1/_2$ to 1 degree toward the close of day. Epistaxis, although seldom severe, is frequently present in a minor degree, sometimes only tinging the nasal passages with blood. The bowels, which have heretofore been constipated, are now not infrequently excessively loose, showing that the lower digestive mucosa is likewise implicated. In many cases this is a critical period and requires careful attention, lest, in delicate subjects, or when the disease is unusually severe, complications or some of the various departures from the normal ensue.

In a few hours the punctate dots on the face are observed to have increased in size as well as in number. On the second day and sometimes earlier the whole face becomes involved as well as the neck, upper part of the chest, and back. At this time it may be observed that the lesions tend to appear either singly or in groups, in the latter case forming crescents[442] or irregular, broken circles. During the first day of the eruption the lesions sometimes assume a slight urticarial appearance, and are perceptibly elevated above the surrounding skin. This can more readily be detected by the touch. More frequently, and always after the first day, the spots have a soft, velvety feel. Pressure with the fingers causes the redness to momentarily disappear. When fully formed the lesions vary in size from $^1/_{24}$ to $^3/_8$ inch (1 millimetre to 1 centimetre) in diameter. Usually, however, they range from $^1/_{12}$ to $^1/_8$ inch (2 to 3 millimetres). They are well defined, round, oval, or irregular in shape; of a dark-red, or, later, slightly purplish color, which in some instances finally assumes a distinct dusky or violaceous tint. This latter is not infrequently referred to by the laity as "black measles." The frequency with which this is met with, however, seems to be less than in former times, judging from the description of the older writers, among whom may be mentioned Trousseau, Hebra, Mor-

[442] Apparently first described by Willan (*loc. cit.*).

PLATE XXXV.

PLATE XXXV.

Rubeola, showing the Eruption during the First Day.

ton, and Sydenham. The skin between the lesions remains intact, although the whole face has a puffy, œdematous, sometimes erythematous, appearance.

The eruption extends over the trunk and extremities, including the palms and soles, the forearms and legs being the last to become affected. It is usually completed on the evening of the third or early on the fourth day of the eruption. With the full development of the exanthem the constitutional symptoms subside. This is evidenced by the degree of fever, rapidity of pulse and respiration, as well as the catarrhal symptoms of the upper mucosæ. The temperature, which not infrequently attains a height of 104° or 105° F. (40° to 40.5° C.), now either rapidly falls (crisis) or more frequently gradually subsides (lysis); so that in the course of from two to three days the normal bodily temperature is reached.

Sometimes a subnormal temperature is observed for some days, or until the patient regains his accustomed strength. Even before the full development of the lesions on the extremities, which are the last to appear, those first developed begin to subside. When the eruption is confluent, this is often preceded by a general blending of the spots, forming more or less extensive *plaques* of erythema. (See Plate XL.) Usually the most characteristic lesions are found on the trunk and especially on the chest. About the joints or between folds of the skin the eruption is always plentiful and the lesions often blend. In the latter positions small vesicles sometimes occur. The full development of the lesions on any particular part is completed in about twenty-four to thirty-six hours after its appearance. On the face pressure with the finger no longer causes a complete disappearance of the redness as at first observed, but a slight yellowish or brownish tint remains. The bright-livid color gradually fades to a faded rose tint and the prominence of the spots subsides.

With the appearance of the eruption the remittent and intermittent character of the fever, which we have heretofore observed, ceases, and there is a more continuous elevation of temperature for two or three days, or until the full development of the cutaneous exanthem, when it reaches the highest point. Thomas[443] observed with considerable regularity the maximal temperature occurring at the end of the fifth or on the sixth day after the onset of the disease. It may be remarked that the maximal temperature, and consequently the acme of the dis-

[443] Thomas: Article on "Measles" in Ziemssen's "Cyclopædia of the Practice of Medicine" (New York, 1897), vol. ii.

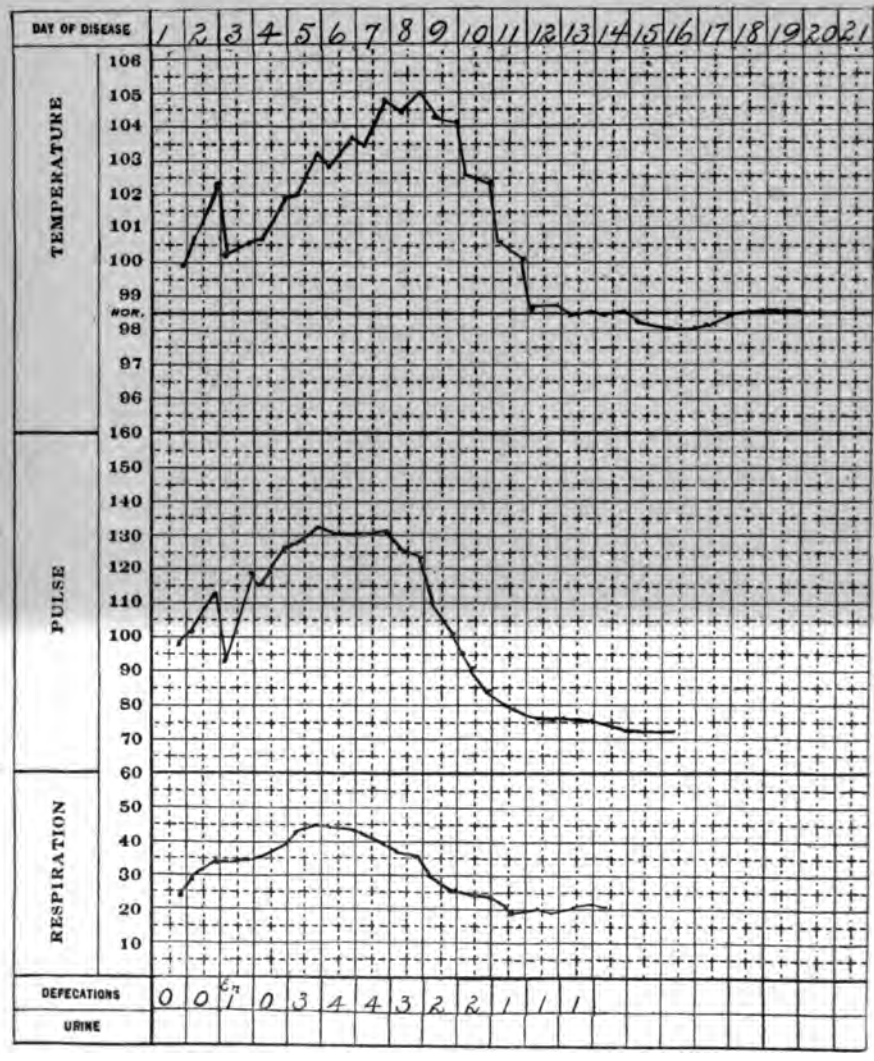

Chart of Severe Case of Measles ending in Recovery without Complications.
(One of the Writer's Cases.)

ease, occurs with greater regularity than has been shown to be the case in either the prodromal or the eruptive stage. The fever seldom exceeds 105° F. (40.5° C.), although Hunter[444] reports a temperature of 110° F. (43.3° C.) in a child sixteen months old which ended in recovery.

The catarrhal symptoms continue to increase in severity with the development of the rash; the face is often swollen and erythematous independently of the eruption; the nasal discharge becomes sero-purulent; the cough is looser, with moist râles heard on auscultation; and not infrequently the sputum is copious and of a sero-purulent or nummular character. There is usually some prostration, and the patient prefers a recumbent position. The pulse is frequent and the breathing is short and sometimes labored. At this time one should be on the lookout for bronchitis or pneumonia, which so frequently appear during this stage. Diarrhœa is seldom absent, even when the bowels have previously been unaffected. The stools sometimes partake of a choleraic character, and pain in the abdomen may be more or less severe. Headache is sometimes complained of, and vomiting has, though rarely, been observed. The urine seldom shows any special changes—aside from the diminished quantity, deep color, and plentiful supply of urates common to all acute febrile disorders—until the full development of the disease, when it may show a distinct trace of albumin. Irritability of the bladder is sometimes present. The presence in the urine of epithelial lining from the urinary tubules is seldom observed, although hyaline casts have been reported. It may be said further that the diazo-reaction was well marked in two cases under the author's care, and that acetonuria and propeptonuria have been reported. These adventitious products, however, have no special prognostic significance. Finally the clinician must not lose sight of the fact that the symptoms detailed are present to a greater or less degree in the majority of cases, and that no two cases are exactly alike. He must expect, therefore, to find all grades of severity and numerous variations in clinical appearance. The duration of this stage is usually from four to five days, more rarely it is six days.

DECLINE.

Stage of Desquamation (*Stadium Desquamationis*), or Convalescent Period.—On the second day of the exanthem the catarrhal

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[444] Hunter: Brit. Med. Jour., April 30, 1898.

symptoms, together with the œdema and eruption on the face, begin to subside, and on the following morning the temperature is found to be lower than on the morning preceding. This is subject to some variation, and may take place a day sooner or later. The redness of the various mucous surfaces—the nasal passages, buccal cavity, and conjunctivæ—now fades away, and there may be at times a slight desquamation observed in the mouth. The eruption on the skin of the face, neck, and upper part of the chest departs in the order named, and on the fourth or fifth day of the eruption the temperature has usually returned to the normal. It may be remarked that sometimes a subnormal temperature is observed for a few days, which disappears as the patient's appetite returns and strength is regained. The eyes are less sensitive to light, free perspiration takes place, the tongue clears, the appetite returns, and on the skin a slight branny desquamation takes place. This latter is less marked than in scarlet fever, and on the trunk and extremities may entirely escape notice. It is best seen on the sides of nose, temples, and chin. Large, flaky scales are very seldom observed in measles. After the eruption disappears a certain amount of pigment remains for a week or two on the sites previously involved.

There is usually some prostration still experienced, and the patient is very sensitive to cold or draughts of air. The coarse mucous râles now give way to those of a sibilant character, which, in turn, gradually disappear. The duration of the stage of efflorescence is not regular; usually it occupies from ten to fourteen days before desquamation is complete. It is advisable to keep the patient within doors, or at least to guard him from undue exposure for a week or more, or from three to four weeks from the beginning of the attack.

RUBEOLA ANOMALA ([*a*] BENIGNA, [*b*] MALIGNA).

ATYPICAL, OR ANOMALOUS, CLINICAL FORMS.—It has been shown that the various symptoms of normal measles vary greatly in different individuals, and more especially in different epidemics; hence much latitude must be given to the measles type. Cases do, however, present themselves in which one or more of the cardinal features are absent or appear only in a minor degree. Again, extraneous conditions and complications, sometimes arising from some inherent peculiarity of the organism, as in rachitis and tuberculosis, may greatly influence the

PLATE XXXVI.

PLATE XXXVI.

Rubeola, Mild Form, showing Clustering of Lesions on Arms.

general trend of the disease or modify the order of its symptoms. Finally, aside from these, the disease may show unwonted severity. Thus, we have what may be grouped under the head of mild forms, and by way of distinction those to which the name severe or even malignant may be applied. Edgar,[445] in an epidemic of 423 cases, found only 123 which adhered to the regular type.

MILD FORMS.—First may be mentioned those cases in which the catarrhal symptoms are slight or entirely absent (*morbilli sine catarrho*), as in a case reported by Harris.[446] Usually in such cases there are also less fever and other concomitants of the prodromal stage (*morbilli sine febre*). At other times the prodromal symptoms may be well marked and the catarrhal disturbance severe, while the cutaneous exanthem is almost wholly absent (*morbilli sine morbillis*). Such cases may readily be overlooked when they occur in the absence of an epidemic, or with other well marked cases which adhere to the usual type. The frequency with which these anomalies are met with may be inferred from Edgar's report previously referred to, in which, of 423 cases, the only constant symptoms were the rise of temperature and the eruption. Again, the rash may appear as usual after about four days of preliminary fever, but not in the order heretofore observed nor to the same extent. It may appear on the face only, or extend to the trunk and quickly disappear, even before the individual spots have time to mature. Embden[447] observed twenty cases of this kind during an epidemic at Heidelberg. At other times the regular form is modified by the very discrete distribution of the lesions, which appear only on certain parts, as on the extremities or trunks, or both. (See Plate XXXVI.) It may further be observed that they seldom become elevated or papular, but remain macular and of a pinkish color. Frequently in these cases the cutaneous exanthem is not only slow to appear, being delayed one or more days, but it manifests an equal tardiness in extending over the body. One might well be inclined to doubt the existence of measles in some of these minor or abortive forms were it not that they have been recorded by careful observers, and that such cases appear to confer immunity to subsequent attacks. The order in which the eruption appears is likewise subject to some variation. Mayr[448] long since called

[445] Edgar: Canada Med. Record, December, 1892.

[446] Harris: Lancet, February 21, 1891.

[447] Embden, quoted by Williams, Article, "Measles," in "Twentieth Century Practice of Medicine" (New York, 1898), vol. xiv, p. 133.

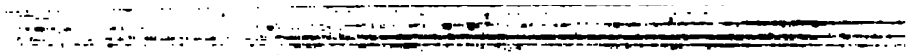
[448] Mayr: "Morbilli," in Hebra's "Diseases of the Skin," "Sydenham Society Transactions" (London, 1866), vol. i, p. 163.

attention to the fact that any local irritation—such as is produced by tightly-fitting bands, garters, or the application of ointments—may act as a determining cause, the eruption appearing first on these parts. He also observed that paralyzed regions or members usually remain free. These mild forms are said to be most frequently observed at the beginning and at the end of an epidemic.

SECOND ATTACK.—A *relapse* is said to occur in rare instances after the exanthem has disappeared. This has been observed most frequently about the end of the second week, and is accompanied by a return of the fever and, to a less extent, of other constitutional symptoms. Cases of this kind have appeared from time to time in medical literature, and recently they have been observed by Lemoine,[449] Sévestre,[450] Fischer,[451] Vergely,[452] Feltz,[453] Roger,[454] and others. Measles recurring a few days after apparent recovery from the first attack has been observed by Löschner,[455] Spiess,[456] Lippe,[457] and others. Such a case was seen recently in consultation by the author. In this instance there was an interval of eight days between the subsidence of the eruption and the second efflorescence. In both attacks the usual symptoms were present, although the exanthem was best marked in the second. (See Plate XXXVIII.) Fischer saw three sisters, aged one, four, and eight years, in all of whom relapse occurred on the ninth, sixteenth, and thirteenth days, respectively. Vergely, in the case of a girl ten years old, observed a second attack of measles ten days after the efflorescence of the first attack. In this case all of the symptoms, including exfoliation, returned. Vergely did not regard it as a relapse, but a second attack. Another form of recurring measles has been described by Trojanowsky,[458] in which the primary exanthem is said to be slight and accompanied by high fever, which lasts about six to eight days, followed by an interval of normal temperature lasting about eight days. Thomas regards this as a form of relapsing fever accompanying measles, seen only in countries where relapsing fever prevails. On the other hand, in an observation of more than 700 cases

[449] Lemoine: Bull. Méd., January 1 and 8, 1896.
[450] Sévestre: *Ibid.*
[451] Fischer: Correspondenz-bl. f. Schw. Aerzte, September 15, 1898.
[452] Vergely: Rev. mens. des Mal. de l'Enfance, August, 1898.
[453] Feltz: Gaz. Heb. de Méd., 1896, Nos. 84 and 87.
[454] Roger (H.): *Loc. cit.*, p. 294.
[455] Löschner: "Jahrbuch f. Kinderheilk.," 1868.
[456] Spiess: "Frankf. Jahresber. über die Verwalt. des Med. wes., Krankenanst.," 1867, xi, p. 40.
[457] Lippe, cited by Thomas.
[458] Trojanowsky: Dorpat med. Ztschr., 1873, iii.

PLATE XXXVII.



Rubeola, showing a Typical Eruption on the Second Day.

PLATE XXXVIII.

Rubeola, Posterior View of the Preceding, on the Third Day of the Eruption.

of measles reported by Camby[459] not a single relapse or recurrence was seen.

While it must be admitted such cases do occur, yet the author believes, from a study of many cases in which a secondary rise of temperature, accompanied by a slight roseolar or macular eruption has taken place during convalescence from measles, that many of the so-called relapses are due, in reality, to complications or attacks of rubella rather than to a direct reintoxication by the specific virus.

SEVERE, OR MALIGNANT, FORMS.—On the other hand, the disease may assume unwonted severity, to which the name malignant measles is often applied. Of the 423 cases reported by Edgar, 103 were of the malignant type, having various complications, which in 7 terminated fatally. This term, however, should be used with discretion, as it applies only to infrequent, isolated cases or to certain epidemics. So far as the writer's observation goes, this latter is dependent upon debilitating causes, which, in turn, are due to various extraneous conditions, especially such as relate to hygiene and exposure to excessive heat or cold. The influences pertaining to camp life and large armies often act as predisposing causes; hence the name "camp measles" sometimes applied to this form. Again, the period of efflorescence may be modified and the eruption appear well-nigh simultaneously over the whole body. Such cases are usually accompanied by high fever and an aggravation of the symptoms of the eruptive stage. As a rule, however, the eruption is of shorter duration, and the concomitant symptoms more quickly subside than in the normal type. Neither can this form be considered especially malignant, as the anomaly does not apparently influence the death-rate. This form occurs more commonly in children than in adults. There is another form in which the eruption rapidly recedes soon after its appearance. When the fever and other symptoms subside *pari passu*, the case is liable to terminate favorably; but with the continuation of a high temperature, rapid pulse, and labored breathing and great prostration, death is liable to supervene. The fatal issue most frequently occurs on the second day of the exanthem. The retrocession of the eruption is not the cause of the unfavorable course, as commonly supposed, but is dependent on the severity of the disease, or more properly the active involvement of the internal organs. Great apprehension was shown at one time lest the eruption "strike in," and the laity still manifests great satisfaction on seeing "the disease come out."

[459] Camby: *Ibid.*

In certain epidemics, especially when occurring in crowded or ill-conditioned institutions, measles may present what is called the TYPHOID OR ATAXIC FORM. Such cases not infrequently occur among troops after a long period of exposure, or during a siege in time of war. In these cases the constitutional symptoms soon take on an alarming character, accompanied by a rapid rise of temperature, 104° to 105° F. (40.0° to 40.5° C.), and a frequent, compressible pulse, which in children attains a rapidity of 130 to 145 beats per minute. The respirations are likewise rapid, usually varying from 50 to 80. The mouth becomes parched, the tongue dry, and the lips cracked. The bowels are loose and the quantity of urine is always greatly diminished. The nerve-centres are profoundly impressed by the specific toxin, and repeated convulsions are not uncommon in children, while in adults delirium, either low or boisterous and violent, is sometimes observed. This is followed by great prostration, and the patient not infrequently passes into a comatose stage, which terminates in death. This is most liable to occur on the third or fourth day of the eruption. At other times these symptoms subside, and the case subsequently follows a protracted, though otherwise normal, course, which leads to recovery.

In other cases the respiratory organs are severely attacked, giving rise to dyspnœa even during the prodromal stage, and as the eruption appears the difficulty in breathing becomes more marked. This is called the SUFFOCATIVE FORM, and is accompanied by frequent coughing of a hacking character, accompanied by expectoration of frothy mucus. The dyspnœa is especially troublesome and sometimes the patient becomes rapidly cyanotic. Mucous râles are heard at an early stage, which in unfavorable cases rapidly increase in number. When the first onset is survived, such cases usually terminate in capillary bronchitis; and especially is this true of children. The immediate cause of death is usually ascribed to heart-failure, while in adults death more frequently is due to syncope. In common with all grave complications of the viscera, the eruption is scanty and liable to fade away soon after its appearance.

Finally we have the HÆMORRHAGIC FORMS (*morbilli hæmorrhagica*), "black measles," of which there are two varieties. Under the first may be included those cases of a mild nature in which the hæmorrhage has little influence on the course of the disease and which usually terminate favorably. The second applies to unusually severe or malignant cases in which the hæmorrhage often greatly intensifies the original disease and from which the patient seldom recovers.

The MILD FORM of hæmorrhagic measles is not of infrequent occurrence. Holt (*loc. cit.*, p. 915) found it in 5 per cent. of all cases. Edgar (*loc. cit.*), during an epidemic of 423 cases, found 200 cases, or 47 per cent., of the hæmorrhagic form. Its frequency, however, is subject to great variation, and it is more common in some epidemics than in others.

Usually there is no premonition given, the appearance of the discoloration being the first symptom to attract attention. The cutaneous exanthem assumes a dark-bluish or purplish tint, which gradually deepens, as the process continues, to a bluish-black color. It does not disappear on pressure. Sometimes the discoloration is confined to the maculæ, at other times numerous specks, or petechiæ, varying from a pin-head to a lentil in size, appear in the sound integument between the lesions of the exanthem. In distribution the extravasations likewise vary greatly in different cases. The lower extremities alone may be involved, or the trunk may be invaded, while the arms, neck, and head remain free. More frequently the whole body shows a general tendency to bleed. The mucous surfaces are implicated in like manner, giving rise to epistaxis, bleeding from the gums, dysenteric stools, and hæmorrhage from the genito-urinary tract. With the subsidence of the efflorescence the hæmorrhagic areas assume a yellowish tint, and in the course of a week or ten days gradually disappear. Convalescence from this form is somewhat prolonged, otherwise the normal course of the disease is usually maintained. At other times the general symptoms are severe, being not infrequently accompanied by severe nausea and vomiting. Dysenteric stools are seldom absent, and in young children this form frequently leads to broncho-pneumonia and death. In adults, or when occurring in well nourished subjects, the presence of hæmorrhage does not, to any great extent, influence the mortality of the disease.

The MALIGNANT FORM, which seems to have been so widely prevalent during the eighteenth century, is now seldom encountered. The severity of the disease is dependent largely on the condition of the patient previous to the attack and the hygienic conditions in which he lives. Those who are prone to hæmorrhagic extravasations, hæmophilic subjects or "bleeders," are, of course, especially predisposed. Again, children under three years of age who are confined within doors, or live in crowded or unwholesome asylums and foundling hospitals, furnish a large contingent of these cases.

Unlike the preceding variety, the malignant form greatly influ-

ences the course and termination of the disease. It may be ushered in by severe epistaxis during the prodromal period, in which case there is no primary remission of the fever during this stage, and with the appearance of the rash the severity of the symptoms increases with alarming rapidity. Nor does the exanthem appear in the order observed in the normal type. Not infrequently there is a more or less complete retrocession of the rash during the first or second day. This is accompanied by great prostration, twitching of the muscles, and sometimes involuntary evacuation. During this time the rash takes on a blue-violet, livid, or black color, or there appear petechiæ, vibices, and purple blotches or ecchymoses on various parts of the body. Blood oozes from the gums, the sputum is tinged with blood, blood is discharged from the bowels, or the evacuations are tarry in color and the urine is mixed with blood. With this the pulse is compressible, weak, and rapid; the respirations are hurried; and the patient sinks into a profound collapse. Death may take place at any time, and usually occurs within forty-eight hours after the onset of the hæmorrhagic symptoms.

Between these extremes all grades of severity exist.

COMPLICATIONS AND SEQUELÆ.

The complications of measles are, on account of their frequency and fatality, by far the most important features to bear in mind in considering this subject. In 60 cases of measles Haig Brown (*loc. cit.*) found complications and sequelæ in 48, and absent in only 12 cases. As will be shown, they may appear at any stage, and sometimes the symptoms to which they give rise completely mask or supersede those of the original disease. Again, they give rise to grave conditions which continue for an indefinite period and are known as sequelæ.

The Skin.—The early cutaneous concomitants of measles are of importance mainly from a diagnostic point of view, as they have a very limited influence on the course of the disease. It has been shown that *erythema* often appears during the prodromal stage, and in this feature measles bears some resemblance to variola and scarlet fever. More frequently it supervenes during the stage of efflorescence, when for the most part it is limited to the face, neck, and upper part of the trunk. It is of short duration and fades away with the full development of the exanthem.

In young children, as a result of free perspiration, *miliary vesicles* are sometimes observed. They are, in reality, sudamina, and appear on parts plentifully furnished with sudoriparous glands, as the neck,

axillæ, and inner surface of the thighs, and more especially when these surfaces are thickly covered with the rash. This sometimes gives rise to itching, and may lead to an error in diagnosis; but further than this sudamina are of little importance and do not affect the regular course of the disease. From the wide-spread vascular disturbance in the skin one would naturally look for certain inflammatory complications of the integument during an attack of measles. This not infrequently is the case, although they are, for the most part, of a mild nature which do not call for special consideration. *Eczema* is sometimes observed, and in those specially predisposed it may persist long after the efflorescence which gave rise to it has disappeared. *Psoriasis* likewise has been known to make its first appearance during the desquamative stage, or soon after the disappearance of measles, although we have no ground for believing that in such cases measles acts otherwise than as an exciting cause in a predisposed subject.

From the disrupted condition of the cuticle, extraneous pathogenic organisms readily gain access to the underlying structures of the skin; hence the appearance of the coccogenous dermatoses, such as *impetigo, furunculosis,* and *phlegmonous abscesses.* These are met with far less frequently in measles than in variola, and seldom lead to the extensive suppurations so common in the latter disease.

Cases of measles accompanied by a *bullous eruption* resembling pemphigus have been reported by Du Castel,[460] Krieg, and Löschner,[461] and quite recently by Baginsky.[462] In one case Baginsky found diplococci, in another the streptococcus pyogenes was found. Both cases terminated fatally. These are probably instances of the bullous form of impetigo.

Cases of *cutaneous tuberculosis* following measles have been reported by Du Castel,[463] Haushalter,[464] and Adamson.[465] According to Du Castel, cutaneous tuberculosis more frequently follows measles than is generally supposed. It is usually widely disseminated, and attacks the face, upper extremities, and, to a less degree, the trunk and legs. At first it appears in the form of small nodules of a deep-red color. Later it may present larger patches varying from a dime to a quarter dollar in size, which are apparently formed by the union of the original

[460] Du Castel: Rev. gén. de clin. et de Thérap. (Paris, 1897), xi, p. 609.
[461] Quoted by Thomas (*loc. cit.*).
[462] Baginsky: Archiv f. Kinderh., H. 1 and 11, B. 28, 1900.
[463] Du Castel: Annal. de Derm. et de Syph., 1898, tome ix, Nos. 8 and 9, p. 729.
[464] Haushalter: Annal. de Derm. et de Syph., 1898, tome ix, No. 5, p. 455.
[465] Adamson: Brit. Jour. of Derm., 1899, p. 20.

nodules. They appear very soon after the measles eruption and rapidly attain their full development, when they remain with little or no change for a long time. A few lesions show a tendency to spontaneous resorption, leaving, in some instances, the characteristic lupous cicatrix. In the two cases reported by Haushalter inoculation of guinea-pigs with portions of the lesions gave rise to tuberculosis in these animals.

The early implication of the nerve-centres, which sometimes occurs in measles, favors the development of certain dermatoses which are ascribed either to reflex disturbances or to an irritation in some portion of the nervous tract. Among the most conspicuous are *urticaria* and *herpes*. In the author's experience, the former is the more common, and apparently is due to a reflex disturbance arising from peripheral irritation in the digestive tract. In two cases Claus[466] reports urticaria occurring during the incubative stage of measles. In herpes the face is the part most frequently involved (herpes facialis). Thomas (*loc. cit.*) mentions zoster femoralis occurring in connection with measles.

Mucous Membranes. — Of all structures none show greater susceptibility than the mucous membranes to the virus of measles. Not only do the characteristic lesions first appear on them, but they furnish the *nidus* for by far the most serious complications. In this two main factors may be recognized: First, the natural tissue resistance, or the *vis medicatrix naturæ* of the older writers; and, second, the invasion and subsequent development of pathogenic micro-organisms. The mucous surfaces in measles present a favorable culture medium for the growth and development of bacteria of various degrees of virulence. This is especially so in debilitated subjects, or when the secretions are allowed to remain and accumulate within the body. As to the second factor, it is quite generally known that in health various micro-organisms—such as the pneumococcus, the streptococcus pyogenes, and the staphylococcus pyogenes aureus—are found in the mucous secretions of the respiratory tract without producing any ill effects. Kyle[467] found the bacillus of diphtheria on the nasal mucous membrane after inhaling the air of a diphtheritic ward, and the bacillus of tuberculosis after the individual had been exposed to the dusty air of the street. In health, or more properly, when the physiological resistance of the structures is maintained, these are innocuous. It is only when a suit-

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[466] Claus: Jahrb. f. Kinderh. u. phys. Erzieh., June 5, 1894.

[467] Kyle: "Diseases of the Nose and Throat" (Philadelphia, 1899).

able soil is found that they proliferate and develop the virulence peculiar to each.

The Eyes.—Although the eyes suffer less frequently than in variola, yet, in common with the other mucous surfaces, the congestive disturbance of the conjunctivæ in measles at times sets up severe inflammatory and destructive changes. In scrofulous children a profuse blennophthalmia is not infrequent, which leads to abscesses of the conjunctiva or keratitis, resulting when neglected in ulceration of the cornea and a train of other misfortunes, such as perforation or destructive panophthalmitis, which so frequently follows. When the cornea is involved, there is always extreme sensitiveness to light. Again, in more favorable cases the lids alone are involved, when we may have phlyctenular ulcers, blepharitis, abscesses at the ciliary margin, and, finally, granulation of the lids.

The Ears.—The catarrhal inflammation of the Eustachian tube and cavity of the middle ear offers conditions favorable to the development of various pathogenic organisms, such as the staphylococcus albus and aureus, and in some instances to the streptococcus pyogenes. When the patient is in a recumbent position the free escape of the augmented secretion becomes retarded, resulting in the development of highly virulent and infective pus. This condition, which is spoken of under the general term *otitis*, is, next to the laryngeal and pulmonary disturbances to be described, the most serious of all the complications of measles.

Its insidious development from the usual congestive disturbances previously described may escape notice until extensive suppuration has taken place. At other times the patient complains of pain in the ear, or sometimes there is great restlessness, grinding of the teeth, sudden cries in children, and delirium in adults. The first indication may be a sudden rise of temperature, which should always put one on guard against some serious complication. In very young children its location may not easily be determined, rendering the diagnosis at first largely conjectural. In most cases it appears about the end of the second week of the disease, although, as pointed out by Tobeitz,[468] it may be recognized post-mortem as early as the first day of the cutaneous eruption and is usually well marked by the fourth day. In addition to the pain complained of, loss of hearing may soon be detected, when an examination often reveals evidences of inflammation about the margin

[468] Quoted by Williams (*loc. cit.*).

laryngeal surfaces. This is supposed to be due to a streptococcus (which is identical in microscopical appearance with that found in erysipelas and suppuration) giving rise to a highly coagulable albuminous exudate. *Membranous laryngitis*, or croup, associated with measles, occurs, for the most part, in large foundling institutions where children are congregated and where the rules of hygiene are not strictly adhered to. Children under three years of age are especially liable to this form. It appears during the eruptive stage, as early as the third or fourth day, or it may set in at any time up to the second week after the appearance of the eruption. It is usually accompanied by a dry, shrill cough. The voice takes on a whispering character, and the false membrane may extend upward to the fauces and tonsils, or downward into the trachea. Dyspnœa is usually marked, occurring at first in paroxysms, which gradually become more and more frequent until asphyxia ensues. At other times there is little warning of approaching asphyxia until the struggle for breath occurs, which frequently terminates in death from exhaustion. In l'Hôspice des Enfants Assistés Granlou,[472] in an observation of 1633 cases of measles, found membranous laryngitis occur 235 times, of which 218 proved fatal; whereas, among the remaining 1398 cases in which this complication was absent, only 388 died.

Diphtheria.—Some difference of opinion exists as to the nature of membranous laryngitis and its relation, if there be any, to diphtheria. Without entering into the discussion of a subject more properly treated of in other works, it may be said that membranous laryngitis is probably due to pyogenic cocci, while the Klebs-Loeffler bacillus is now generally accepted as the specific contagium of diphtheria. The latter disease may also occur in connection with measles. It is far more infectious, however, and the fever and general constitutional symptoms are characterized by greater severity than is usually observed in croup. In an epidemic of 96 cases reported by Adriance[473] in the Nursery and Child's Hospital, of New York, 36 were complicated with diphtheria, 4 of which proved fatal.

The Lungs.—The tracheo-bronchial catarrh which is recognized as one of the common disturbances of measles sometimes goes beyond the limit ascribed to it as normal, and either by its severity or dire consequences entirely supersedes in importance the original disease. It is a matter of common observation that all are not equally predis-

[472] Granlou: "La Rugéole à l'Hôspice des Enfants Assistés" (Paris, 1892), IV.
[473] Adriance: Archives of Ped., Feb., 1900.

posed to pulmonary complications. This applies in like manner to other complications of measles; in fact, in private families the death-rate in some epidemics is less than 1 per cent., while in the Hôspice des Enfants Assistés in Paris the death-rate during the three years preceding 1885 reached the appalling fatality of 44 per cent., of which secondary infection of the lungs furnished, by far, the greatest number. On improving the hygienic conditions in this hospital, especially those relating to sunlight and ventilation, it has been found possible to reduce the fatality of measles one-half. It may be readily understood, therefore, that delicate or rachitic children, or others predisposed to bronchitis, are especially susceptible during an attack of measles to the pulmonary complications herein to be considered.

It has been shown that many pathogenic cocci and bacilli, as well as numerous unclassified non-pathogenic germs, are found on the mucous surfaces of the respiratory tract. It has also been shown that the catarrhal disturbances peculiar to measles offer a fertile field for their further development, which accounts for the frequency of tracheitis and bronchitis to a greater or less extent. While admitting that in the great majority of cases these affections pass away without serious consequences, yet, at times, bronchitis, especially, assumes a more virulent character, either by extension from the larynx or from its development *in loco*, when it must be considered a complication of no little importance. In strumous young subjects who have not yet passed the second decennium the trachea and larger bronchial tubes are often involved in a subacute inflammation which is characterized by a profuse sero-purulent expectoration. This may continue long after the disease which gave rise to it has disappeared, and not infrequently leads to tuberculosis of the lungs. This variety is sometimes spoken of as *phlegmonous bronchitis*.

A more serious complication consists in the involvement of the smaller ramifications of the bronchial tubes, giving rise to *capillary bronchitis*. This is one of the most serious complications of measles. It usually occurs during the period of efflorescence, and may be recognized by a continued rise of temperature when the cutaneous exanthem has begun to subside, or by a chill followed by fever, headache, and vomiting. With these there is an aggravation of the cough and respiration becomes frequent and more labored. The patient soon shows signs of deficient blood-aëration, and alarming dyspnœa and adynamic symptoms rapidly follow. It is usually of general distribution, involving one or both lungs. The physical symptoms are the same as

observed in capillary bronchitis when measles is not present. At first sibilant râles are widely distributed, followed by moist râles, which become especially wheezing on expiration. There is usually a feeble respiratory murmur, and the resonance on percussion is sometimes slightly increased.

Broncho-pneumonia. — The most fatal as well as the most frequent complication of measles is broncho-pneumonia. Houl[474] encountered it in one-fifth of all cases. In two epidemics embracing 300 cases in the Nursery and Child's Hospital, New York, Holt[475] observed it in 40 per cent. of all cases, of which 70 per cent. proved fatal. Its prevalence is especially marked in foundling institutions and asylums, and it is directly due to the development of various organisms, of which the pneumococcus of Friedländer and the micrococcus pneumoniæ of Fränkel play a conspicuous rôle. When this complication supervenes the eruption rapidly subsides; there may or may not be a chill or repeated rigors, but the temperature always rises, and the pulse, at first full and incompressible, soon becomes weak, small, yielding, and irregular. It is always greatly accelerated. Respiration is short and frequent, the cough is hacking, often spasmodic and difficult to repress, and the usual signs of pneumonia with marked prostration become rapidly developed. The physical examination reveals at first rhonchi and widely disseminated subcrepitant râles, which soon give way to deficient resonance, bronchial breathing, and fine crepitations. This complication may arise as early as the first day of the exanthem, or more rarely as late as the second week. In young children its onset is acute, with rapid pulmonary congestion, and usually terminates fatally within two or three days. In older children or adults the affection of the lungs usually pursues a more subacute course, is more frequently of the lobar variety, and sometimes leads to the so-called caseous pneumonia, or phthisis pulmonalis.

The Digestive Tract.—The mucous membranes of the digestive tract are nearly always involved to a greater or less extent in measles. Stomatitis not infrequently follows the congestive disturbance of the mouth which has been shown to be one of the constant symptoms of the disease. While it seldom gives rise to serious consequences, its presence cannot be wholly ignored. As in other mucous surfaces the condition offers a suitable soil for the development of numerous micro-organisms. The regions most commonly involved are the sulci be-

[474] Houl: Wiener klin. Rund., 1897, vol. xi, p. 833.
[475] Holt (*loc. cit.*).

tween the cheek and gums. The process may remain limited or extend to contiguous parts. At first whitish patches form, which soon become denuded of epithelium, giving rise to superficial ulcers, which extend both at the periphery and in depth. In this way the destructive process may continue until large areas are destroyed, and in rare instances this eventuates in severe *ulcerative stomatitis*. Almost pure cultures of the staphylococcus aureus have been obtained from these lesions. More frequently they are superficial and of short duration, subsiding with, or soon after, the disappearance of the rash.

In other cases the usual catarrhal symptoms do not subside upon the disappearance of the cutaneous eruption. On the contrary, either a subacute or chronic inflammation ensues, giving rise to redness, swelling, and pain on deglutition. The tonsils, especially, are prone to increase in size, and not infrequently suppuration takes place, either in the follicles, when the discharge wells up from numerous openings (*acute lacunar tonsillitis*), or by the formation of a single abscess-cavity (*parenchymatous* or *acute circumtonsillar inflammation*). One or both tonsils may be involved. The process may extend to the stomach, giving rise to nausea, pain, and vomiting of blood. Somewhat more frequently the intestines are affected in like manner, and diarrhœa, which has previously been noted, becomes aggravated. This condition may continue long after the disappearance of the exanthem.

Roger[476] reports secondary infection from the intestinal tract, giving rise to phlegmonous hepatitis, perihepatitis, and pleurisy.

The Nervous System.—The frequency of disturbances of the nervous system associated with measles varies greatly, and seems to depend more on individual peculiarity than on the severity of the attack. While the nerve-centres are more or less impressed in all cases, it is very seldom that any serious complication occurs. Cioffi[477] has advanced the theory that the measles toxin has a marked effect on the vagus, and that, when severe, it at first irritates, then paralyzes, it. This is confirmed by others, and some maintain that the frequency of the various catarrhal conditions, and especially purulent otitis, depend on an irritation of the meningeal branches of the vagus, which at first gives rise to the catarrhal symptoms, and which, in turn, predisposes to simple and tubercular phlogistic affections. Of the more important the following may be mentioned:—

Disseminated Myelitis.—This infrequent complication of measles

[476] Roger: Presse Méd., Paris, 1897, ii, pp. 189 and 192.
[477] Cioffi, Riforma Med., 1900, 51 to 53.

usually makes its appearance at an early stage of the exanthem. It gives rise to stupor, loss of control over the sphincters, difficulty in swallowing, slowness of speech, and inco-ordination, leading to paralysis, which is wide-spread and which may not disappear with the subsidence of the active period of the disease. Cases have been reported by Barlow[478] and Williams[479] in which the post-mortem examination revealed vascular disturbances of the cord.

Hemiplegia.—Many cases of hemiplegia have been reported, although, for the most part, they have not been of a serious nature, and in the vast majority of cases recovery has taken place. Lop[480] divides all paralyses following or associated with measles into two main forms: the cerebral, or those arising from changes in the brain, and the spinal, or those due to disturbances in the cord. Hemiplegia is found less frequently associated with measles, however, than with scarlet fever. Of 120 cases of hemiplegia observed by Osler,[481] 4 appeared soon after an attack of measles and 7 followed scarlet fever. In 80 cases of hemiplegia reported by Gowers[482] 7 were after measles and 7 followed scarlet fever. Hemiplegia, however, is more often a sequela than a complication of measles. Of 9 cases mentioned by Williams, the paralysis appeared during the height of the disease in 4 cases, while in 4 others it occurred during convalescence, and in 1 the time of appearance is not stated. It may, therefore, appear as early as the first or second day, or as late as the third week of the disease. In most cases it has been observed to follow soon after an attack of convulsions, or a series of attacks in which the spasms may be general or limited to the side in which paralysis takes place. More cases have occurred in females than in males.

False disseminated sclerosis is sometimes observed during an attack of measles, especially when accompanied by high pyrexia. Cases have been reported in which the symptoms pointed to acute ascending paralysis resembling very closely that observed in other acute infectious diseases accompanied by high temperature, and which is usually characterized by its rapid development followed by loss of consciousness from which the patient may not rally. If consciousness be regained it is often found that the patient is aphasic and gives mani-

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[478] Barlow: "Trans. Medico-Chir. Soc.," vol. lxx, p. 77.

[479] Williams (Dawson): "Trans. Medico-Chir. Soc.," vol. lxxvii, p. 57.

[480] Lop: Centralb. f. klin. Med., 1893, No. 50.

[481] Osler: "The Cerebral Palsies of Children" (London, 1889).

[482] Gowers: "Manual of Diseases of the Nervous System" (London, 1888), vol. ii, p. 423.

festations of extensive paralysis, paresis, or even ataxia. Even these do not necessarily imply a fatal termination, and the patient may completely recover therefrom. They sometimes, however, give way to a condition resembling disseminated sclerosis which differs essentially from the true disseminated sclerosis in that the symptoms are retrogressive rather than progressive, and more especially tend to recovery. Williams reports paralysis of the soft palate, pharynx, and tongue, as well as the muscles of the neck, which in 4 cases appeared during the earliest days of the disease and in 4 others after three weeks. In all cases recovery took place in from three to twenty days. In cases reported by Barthez and Senné[483] paralytic symptoms appeared during the first few days of the disease, while in other cases they were observed as sequelæ three weeks after the disappearance of the measles. Of these cases all recovered. There is sometimes permanent impairment of the muscles of the throat, especially those relating to deglutition and phonation. Williams refers to this class of affections under four headings, namely:—

(*a*) Acute disseminated myelitis.

(*b*) Cases presenting at a later date symptoms resembling disseminated sclerosis (false disseminated sclerosis).

(*c*) Cases in which, with some symptoms similar to those of the preceding group, the most prominent symptom is inco-ordination.

(*d*) Cases of "extensive, ascending, diffuse, or disseminated" paralysis, resembling diphtherial paralysis.

Tetany is sometimes met with during an attack of measles in very young children or infants. This more frequently occurs when there has previously been a tendency to convulsions.

Muscular Atrophy.—This sometimes appears as a sequela to paralysis following measles. Holmes Coote[484] reports a case of muscular atrophy following measles which gave rise to talipes equinus. In a case reported by Ormerod[485] the father and two children were affected with muscular atrophy following measles.

Chorea is sometimes given among the less frequent sequelæ of measles. Of 439 cases of chorea collected by Stephen Mackenzie,[486] measles is recorded as an antecedent in 116 cases, or 26 per cent. Of these it was the sole antecedent illness in 32 cases, or 7 per cent. These

[483] Rilliet and Barthez: "Traité cliniq. et pratiq. des mal. des enfants" (Paris, 1891), tome iii, p. 38.

[484] Coote, quoted by Williams (*loc. cit.*), p. 151.

[485] Ormerod (J. A.): Brain (London, 1885), p. 335, vol. vii.

[486] Mackenzie: Brit. Med. Jour., Feb. 26, 1887, pp. 425 *et seq.*

statistics, which on account of the care taken in their compilation are of the highest value, fail to show any definite etiological relation between measles and chorea.

Mental Disorder.—Sometimes measles gives rise to an apathetic condition which may, under strong predisposing influences, become permanent. In an analysis of 2000 cases of idiocy made by Beach,[487] 37, or 1.85 per cent., followed an attack of one of the acute exanthemata, of which number measles furnished 11, or over 30 per cent. It may be stated further that, in the majority of cases supposed to be due to the eruptive fevers, there was also a history of insanity, imbecility, epilepsy, convulsions, etc., in the parents or other members of the family. Finkelstein[488] has reported two cases of acute mania during measles, and Bond[489] observed acute mania on the eighth day of measles.

The Heart.—Structural changes in the heart must be conceded to be among the very rare complications of measles. That the heart-muscle is weakened during a severe attack of measles as in other high pyrexias is a matter of common observation, and death may take place from what is commonly called "heart-failure." According to Williams, fatty degeneration has been found post-mortem in cases in which the first sound had been toneless and in some instances had been accompanied by a systolic murmur. Endocarditis has been known to make its first appearance during the course of measles. Such cases have been reported by J. Hanley Hutchinson,[490] Cheadle,[491] and others. In 159 cases of measles Haig Brown (*loc. cit.*) observed endocarditis in 1 case and pericarditis with effusion in 1 case. The author is in accord with Stephen Mackenzie,[492] Lee,[493] and Sturges,[494] who believe that the few cases on record do not show any evidence that measles, *per se*, induces heart disease.

The Kidneys.—As in most acute febrile diseases, albuminuria is sometimes found in rubeola. It is, however, less common than in scarlet fever, and seldom leads to any serious consequences. Loeb[495] reports propeptonuria present in 9 out of 12 cases examined during

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[487] Beach (Fletcher): Brit. Med. Jour., 1895, vol. ii, p. 707.
[488] Finkelstein (I. M.): Vrach, No. 20, 1898.
[489] Bond: Maryland Med. Jour., Jan. 29, 1898.
[490] Hutchinson (J. Hanley): "Trans. Medico-Chir. Soc.," 1891, vol. lxxiv, p. 229.
[491] Cheadle: *Ibid.*
[492] Mackenzie, Stephen (*loc. cit.*, p. 429).
[493] Lee: "Trans. Medico-Chir. Soc.," vol. lxxiv, 1891, pp. 229 *et seq.*
[494] Sturges: "Trans. Medico-Chir. Soc.," vol. lxxiv, 1891, pp. 229 *et seq.*
[495] Loeb, quoted by Dawson Williams (*loc. cit.*).

the height of the disease or at the beginning of desquamation. A fatal case of uræmia following measles is reported by Zichy-Woinarski.[496] Ascites and general anasarca are sometimes observed even when the heart and kidneys seem to be normal.

Aside from the complications implicating important organs, measles sometimes gives rise to certain other conditions of a more general character. Tuberculosis of the lungs following pneumonia has already been sufficiently dwelt upon, but measles not infrequently is followed by tuberculosis of the lymphatic glands as well as of other structures, giving rise to the ordinary symptoms of marked struma. In those predisposed the utmost care should be exercised in obviating this condition.

Purpura has likewise been encountered, the two cutaneous manifestations remaining distinct throughout. More frequently when purpura supervenes it modifies the exanthem, constituting the hæmorrhagic form of measles previously considered.

Phlebitis following an attack of measles has been reported by Mackey,[497] of the Children's Hospital, Brighton, England. This case terminated fatally.

Gangrene.—When the tissue resistance is feeble, as in strumous subjects, gangrene of various organs may be encountered as a sequela of measles. Méry and Lorrain[498] observed extensive gangrene of the lung in measles in which there were found, in the gangrenous focus, streptococci, a bacillus resembling the Klebs-Loeffler bacillus, bacilli which morphologically resembled the streptothrix, and a large putrefactive germ. *Cancrum oris*, or noma, has also been reported by Rotch,[499] and vulvitis leading to extensive gangrene of the part has also been encountered. Wunder[500] reports a case of extensive gangrene in the wall of the thorax following measles.

Measles may *co-exist* with *other diseases*. When it attacks a patient with psoriasis or chronic eczema it not infrequently causes the chronic eruption to disappear. This usually returns, however, after the acute exanthem has passed away. Measles and scarlet fever have been observed together by Himowitch,[501] Johnston,[502] and others;

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[496] Zichy-Woinarski: Australian Med. Gaz., Oct. 15, 1893.
[497] Mackey: Brit. Med. Jour., Dec. 19, 1896, p. 1772.
[498] Méry and Lorrain: Anat. de Paris, March, 1897.
[499] Rotch: Pediatrics, 1896, p. 587.
[500] Wunder: Münchener med. Woch., 1897, xliv, 536.
[501] Himowitch: Med. Record, Sept. 7, 1895.
[502] Johnston: Brit. Med. Jour., Dec. 31, 1898, p. 1928.

measles and chicken-pox by Joshua.[503] In these acute affections measles usually appears after the original disease has well-nigh disappeared. There seems to be a special tendency to simultaneous occurrence of measles and pertussis. Bernardy[504] observed it twenty-one times in 166 cases.

Subcutaneous emphysema complicating measles has been reported by Kelly,[505] Felsenthal,[506] and Palleske.[507] In these cases there was an absence of severe cough or any known injury.

Pregnancy associated with measles predisposes to premature delivery, hæmorrhage, and a septic condition. It is far less serious, however, than when accompanying variola, and it is said that the lying-in woman is less susceptible to the disease than others. Pregnancy, it must be understood, offers no safeguard against the contraction of measles. As this disease usually occurs in early youth, it is seldom that the parturient state calls for more extensive consideration.

PATHOLOGY.

Mucous Membranes.—The anatomical changes in measles are first observed in the mucous membranes, and are usually limited to the conjunctivæ, nose, pharynx, larynx, and the larger bronchial tubes. The changes here correspond to those commonly found in ordinary catarrhal inflammation. The secretions at first are transparent, although they soon become opaque, and, according to Mayr,[508] are always of alkaline reaction. The earliest pathognomonic disturbances of measles consist in a dilatation of the capillaries and venous radicals in the buccal mucous membrane, giving rise to a light-bluish tint, or "skimmed-milk color," which is followed, within twenty-four to forty-eight hours, by the dark-red spots previously described. These correspond in the main to those subsequently observed on the skin, excepting that on the mucosa they are less sharply defined, and the congested vessels gradually blend with the surrounding vascular net-work. In an histological study of the early mucous lesions in the mouth Slawyk (*loc. cit.*) found the epithelial cells thickened and in some instances they had undergone fatty degeneration, giving rise to the

[503] Joshua: Lancet, July 13, 1889.
[504] Bernardy: Annals of Gyn. and Ped., July, 1894.
[505] Kelley (S. W.): Therap. Gaz., Jan., 1891.
[506] Felsenthal: Archiv f. Kinderh., B. 14, H. 1 and 2, 1891.
[507] Palleske: Deut. med. Woch., 1898, vol. xxiv, p. 255.
[508] Mayr: Article, "Measles," in Hebra's "Diseases of the Skin," New Sydenham Society (London, 1866), vol. i, p. 177.

whitish dots or vesicular appearance previously referred to. As yet no special micro-organisms have been found in the lesions. Sometimes a more active destructive process ensues, which begins in the lymphatic follicles and is supposed to be due to the intensity of the inflammatory changes. This may go on to the formation of ulcers which frequently extend to the deeper parts. Similar changes have been found in the intestinal mucous membrane, usually involving the lymph-follicles and Peyer's patches. Gerhardt[509] found lesions similar to those observed in the buccal mucous membrane in the larynx and trachea after death. Steiner, following Thomas and Bohn,[510] describes reddish spots on the mucous surface of the intestines, which have some resemblance to the cutaneous exanthem. Von Jürgensen cites Fuchs and others as having found similar changes in the mucous surfaces of the genito-urinary tract.

The Skin.—The first macroscopical appearance of the exanthem occurs about the hair sacs and follicular apertures, which sometimes become raised above the level of the skin, forming minute papules. In some instances vesicles appear at these points, which are due to the closure of the apertures of the coil-glands. Sometimes a number of papules occur close together. Accompanying these changes there is a superficial congestion of the surrounding integument, which presents a well defined margin quite unlike that observed in the inflammatory halo of chicken-pox. This sharp line of demarkation, according to Mayr (*loc. cit.*, p. 177), is due to the cutaneous furrows which limit the capillary injection. When the macules are of large size, they are formed by the coalescence of smaller ones. Anatomical changes in the skin correspond to those observed in acute hyperæmia accompanied by exudation, the latter giving rise to œdema, which may be limited to the individual lesions or appear as a diffuse swelling of the skin.

These changes are first observed in the papillæ, and later may extend to the deeper layers of the derma. Venous congestion gives rise to the cyanotic appearance usually observed, and the papillary œdema may account for the urticarial appearance sometimes seen during an early stage of the exanthem. Unna[511] has called attention to the evanescent anatomical changes which soon disappear during life, and show no marked post-mortem alterations. In this respect it differs from that observed in scarlet fever. At the same time marked evi-

[509] Gerhardt (Carl): "Lehrbuch der Kinderk." (Tübingen, 1871), p. 94.
[510] Quoted by von Jürgensen (*loc. cit.*, p. 94).
[511] Unna: Orth's "Pathological Anatomy" (1894), pp. 627 and 628.

dences of œdema are sometimes present. As the exudate travels in the direction of least resistance, it is observed, especially in early life, in fatty tissue, about the coil-glands, sebaceous glands, and muscles of the skin, as well as about the hair follicles. According to this observer, it is not uncommon to find an individual coil-gland, hair bulb, or a small cutaneous muscle appearing free in these dilated spaces. Besides this, one finds in the under and middle portions of the skin oval or irregular cavities, which appear to be enlarged lymph-spaces. Aside from these well marked changes there is, to a less extent, œdema of the subcutaneous structure. The migration of white blood-corpuscles is not greater than observed in simple hyperæmia from other causes; in fact, it is less marked than in many. Few leucocytes are found in the epidermis. The prickle-cell layer is not thickened, nor does the œdema extend to the interspinous spaces of this layer. Unna has never observed mitosis at the acme of the process, but believes it first appears during the stage of desquamation. On the other hand, there appears a slight anomalous keratosis, in which the stratum granulosum gradually disappears, while the basal horny layer becomes correspondingly thickened. During the period of desquamation the superbasal cells of the horny layer become separated from the basement-layer of the stratum corneum, which with the middle and uppermost cells becomes detached, thus completing the process of desquamation. With this mitosis begins, resulting in the regeneration of the cells thus destroyed. Catrin[512] has observed a marked diapedesis of the white blood-cells in the papillæ, while Neuman[513] noted round-cell proliferation, especially well marked about the blood-vessels, follicles, and coil-glands. The former likewise mentions a colloid degeneration of the deeper strata of the epidermis, which first appears in the perinuclear zone.

In a peculiar eruption which developed in a patient recovering from measles Unna[514] found the eruption bore a close similarity in anatomical structure to that of small-pox. No involvement of the epidermis was found, but the eruption was supposed to be caused by the presence of bacteria in the capillaries of the papillary layer of the derma. Unna has further called attention to thrombosis of the superficial vessels of the skin in measles due to the same cause, which may

[512] Catrin: "Les altérations de la peau dans la rougéole." Archiv. de Méd. experiment., 1891, No. 2.

[513] Neuman: "Histolog. Veränderungen der Haut bei Masern u. Scharlach." "Med. Jahrb.," 1882, p. 159.

[514] Unna: Univ. Med. Jour., Oct., 1895.

occur without hæmorrhage. In post-mortem examinations in which gangrene has occurred streptococci have been invariably present.

The Blood.—No uniform or important changes in the blood have been found in measles. In severe cases it has been observed by some to be post-mortem of a bluish or brownish-red color, while others affirm that it seldom completely coagulates. In other cases after death it has been observed to become thick and tarry; again thin, and of a cherry-red tint. Widowitz[515] in eighteen cases of measles found the hæmoglobin diminished as the fever subsided. In most cases it increased in quantity during convalescence, until it equaled that found during the height of the fever. According to Franz,[516] the hæmoglobin, as determined by Gowers's method, was never greatly diminished, and at times was found actually increased, while the cells counted during the eruptive period showed that they were not decreased, but frequently went above the normal. Any alteration in the erythrocytes as regards form, the formation of rouleaux, etc., could not be determined, and in only one case, during the height of the regeneration of the leucocytes, were two normoblasts found in a single preparation. No marked quantitative change in the blood-plates or in the fibrin formation was made out. He further found in measles a relative, and, in a measure, an absolute, increase of the large mononuclear cells and transitional forms.

The polynuclear neutrophiles most frequently show in the beginning of the disease an approximately normal percentage, occurring usually on those days on which the mononuclear elements are present in greatest abundance. The lymphocytes showed a slight decrease from the normal percentage, not only relatively, but absolutely. This did not occur equally in all cases: gradual variations, depending on the time of observation, were repeatedly observed. Macroscopically, at the time of the regenerative processes of the blood great variation in the form of the single lymphocyte was noticed, many forms being seen which were plainly in transitional stages between the last named and large mononuclear cells. In relation to the eosinophilic cells these observations fail to establish during measles a constant relationship to the other percentages. In single cases they were at the acme of the disease present in diminished numbers and during the time of the regeneration of the blood increased in number,

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[515] Widowitz: "Jahrb. f. Kinderh.," B. 28, S. 25.

[516] Franz (Karl): Wiener med. Woch., 1899, No. 47.

while in other cases this relationship was absent. The most characteristic changes in the blood in measles, therefore, are the almost constant relative and absolute increase of the large mononuclear cells and transitional forms present at the height of the disease and during convalescence, while during this period the polynuclear neutrophiles and lymphocytes are diminished in number.

In the majority of deaths there is a mixed infection, the germ most commonly present in the blood being the staphylococcus pyogenes albus. The streptococcus pyogenes is likewise frequently found, and to it is attributed more serious lesions than those caused by the staphylococcus. These micro-organisms probably gain access through the mucous membrane of the respiratory tract, and, as they are almost invariably present in the wards of a hospital and in ill-ventilated rooms, the frequency of the complications previously noted is accounted for. Le Dantec[517] found in post-mortem examinations of patients dying from measles a general infection by streptococci. V. Hutinel and Paul Claisse[518] have called attention to a condition resembling acute septicæmia occurring during measles in very young children in which the streptococcus was invariably found. Further than this much uncertainty exists.

In 1878 Braidwood exhibited before the Pathological Society of London what he claimed to be the measles bacillus, or the active agent in causing the disease. In 1892 Doehle[519] described certain bodies which he found in the blood in eight cases of measles. In fresh blood they were found both in the plasma and red corpuscles. Later, as the exanthem appeared they were only seen in the latter. These motile bodies measured from 0.5 to 1.0 micron in length and contained an opaque nucleus surrounded by a clear zone. At a later stage oval bodies (2 to 5 microns) were present, containing two or more nucleiform bodies. Doehle believes these bodies to be protozoa. Later, Canon and Pielicke[520] described a bacillus which they had observed in fourteen cases of measles and which they considered the specific organism. It was found in the blood, sputum, nasal and conjunctival secretions during the whole course of the disease; most abundant at the height of the fever and disappearing as convalescence progressed. They were of variable size, sometimes as long as one-half the diameter

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[517] Le Dantec: Gaz. Hebdom. des Sci. Méd. de Bordeaux, June 19, 1892.
[518] V. Hutinel and Paul Claisse: Revue de Méd., May 10, 1893.
[519] Doehle: Centralb. f. allg. Path. u. path. Anat., 1892, iii, 150-152.
[520] Canon and Pielicke: Brit. Med. Jour., April 23, 1892.

of a red blood-corpuscle, at other times much smaller, appearing like diplococci. On the other hand, Josias[521] examined the blood and secretions in twenty-four cases of measles according to the method described by Canon and Pielicke, with a negative result. Among the more recent investigations may be mentioned those of Czajkowski[522] who found bacilli in the blood varying from one-half micromillimetre to the diameter of a red blood-corpuscle, which in cultures grew into long threads. They were found to grow best on bouillon or sterile serous fluid from the abdominal cavity. The cultures appeared as a whitish sediment, which later assumed a grayish color. Rabbits were found to be immune, while mice died from septicæmia in from three to four days after inoculation. Pure cultures were again obtained from the liver and spleen of animals thus affected.

In a study of 665 cases of measles Arsamakor[523] found rod-shaped bodies with bulb-like extremities present in the blood and secretions from the inflamed mucous membranes. They were usually grouped, and measured from 5 to 6 microns in length.

The most recent investigations which promise to clear up the obscurity existing as to the etiology of measles have been made by Lesage.[524] Investigations were made and the disease studied in 200 cases of measles. Rabbits were inoculated with nasal mucus or blood from a large number of cases. The results were positive in nearly every case, and Lesage considers himself justified in announcing that the delicate micrococcus so constantly found has probably something to do with the etiology of measles. So far as it is possible to recognize measles on a hairy animal, he thinks his inoculations induced the disease. The micrococcus is best cultivated on gelose, decolors by Gram's method, and takes stains slowly. The cultures resemble those of the pneumococcus. It was not found in 25 cases of scarlet fever, but constantly in 6 cases complicated with measles and also in 2 cases of measles complicating diphtheria. It was absent in 45 normal children, and found only twice in 53 children who had had the disease previously. Much remains obscure, however, both as to the gross pathology and bacteriology of measles. Future study of the blood may confirm some of the observations made, or reveal something of as yet unknown etiological significance. The pathology of the various compli-

[521] Josias (A.): La Méd. Mod., June 2, 1892.

[522] Czajkowski (Joseph): Centralb. f. Bakt. u. Parasit., 1895, Nos. 17 and 18.

[523] Arsamakor (G.): Bolnitch. Gaz. Botk., 1898, 40 et 41; abstracted in Rev. de Méd., 1899, vol. xix, p. 561.

[524] Lesage: Bulletin de la Soc. Méd. des Hôp. de Paris, March 15-22, 1900.

cations met with in measles differs in no way from that found when not associated with this disease.

According to Franz,[525] Ehrlich's diazo-reaction is present in the urine, as a rule, in nearly all severe cases of measles, and on the average is first present on the third day of the disease. In milder cases the reaction is less commonly developed, may be present for a shorter time, or is absent altogether. In relation to the differential diagnosis, the presence of this reaction in a doubtful case would favor the diagnosis of measles. Its prognostic value in this disease is slight.

In regard to the involvement of the lymphatic glands in measles there is much variability. As a rule, inflammation is less marked than in scarlet fever or German measles. When extensive destruction of tissue takes place, as is sometimes observed in the naso-pharyngeal cavities, enlargement and infiltration of the adjacent lymphatic glands ensue, which in strumous subjects frequently eventuates in suppuration and destruction of the gland-structure. The lungs are implicated in a large majority of cases which terminate fatally. The changes found in the lungs do not, in the main, differ from those observed when unaccompanied by measles. Corneil and Babès[526] maintain, however, that there is a special form of inflammation of the lungs which they believe to be peculiar to measles and due to the direct action of the specific poison. They regard it as the sole cause of death in the so-called suffocative form. It begins as an interstitial pneumonia, at first involving the lymphatic system, the interlobular and interalveolar tissue, which later gives rise to a fibrinous effusion into the alveoli. The anatomical changes found in the central nervous system are at first mainly vascular, and are likewise supposed to be due to the direct toxic effect of the measles virus. Analogy is drawn between similar changes observed in diphtheria, which in like manner are supposed to be due to the specific effect of the toxic agent.

ETIOLOGY.

Measles is eminently a contagious and, to a less extent, an infectious disease. It is usually communicated direct from person to person, and in this way it is the most contagious of the exanthemata. Its communicability, however, has greater limitations than is observed in both small-pox and scarlet fever, because the contagium does not readily adhere to clothing and soon loses its infective property. Fur-

[525] Franz (Karl): Wiener med. Woch., 1899, No. 46.

[526] Corneil and Babès, quoted by Williams (*loc. cit.*, p. 125).

thermore it is known that the infectious material does not readily adhere to the walls or other objects in the sick-chamber; therefore there is less danger of infection from fomites; consequently intermediate contagion is comparatively rare. It is further known that exposure to the air and sunlight for a short time renders the contagium innocuous. In studying the influences which bear on the spread of measles, Richard,[527] from an experience of three epidemics, concludes that: the contagium cannot be carried by fomites or a protected person, neither does it spread through the atmosphere, and that strict quarantine will prevent it.

Bard[528] draws the following conclusions bearing on the etiology of measles: The contagium of morbilli does not remain viable in a locality from which those who have suffered from the disease have gone away. Hence, disinfection of the bed and furniture is unnecessary. Contagion is always direct, from person to person. While it is highly probable that measles is due to a microparasite, yet at the present time no microbe has been identified and proved, beyond reasonable doubt, to be the specific agent. Contagion is possible even three or four days before the eruption on the skin is evident, and continues until desquamation has ceased. In 5 cases collected by Ransome[529] measles was found to be infectious before the appearance of the rash; in 2 cases at least 2 days before that event. In 1 case 3 days before the rash appeared it failed to give the disease to 7 susceptible children. Croskey[530] observed a case in which the disease was apparently communicated 4 days before the rash appeared. Vacher[531] places the duration of infection at 31 days after invasion.

The virus is present in the blood even during the prodromal stage, as has been demonstrated by inoculation. The first successful inoculations of which we have any record were made by Home, of Edinburgh, in 1758. These observations were confirmed by Speranza in 1822 and in 1854 by Bufalini. The catarrhal secretions from the various mucosæ have been demonstrated to contain the infective material by both Mayr[532] and Berndt.[533] Further, the latter observer has demonstrated that the disease may be communicated by desquamating epithelium.

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[527] Richard (V. M.): Therapeutic Gazette, July 16, 1888.
[528] Bard: Revue d'Hygiène et de Police Sanitaire, May 20, 1891.
[529] Ransome: Brit. Med. Jour., Jan. 29, 1887.
[530] Croskey, cited by Ransome (*loc. cit.*).
[531] Vacher, cited by Ransome.
[532] Mayr (Thomas): Article, "Measles" (*op. cit.*, p. 40).
[533] Berndt, cited by Thomas (*loc. cit.*, p. 40).

With the subsidence of the exanthem, however, the disease becomes less contagious, and Mayr was unable to communicate it at this time by rubbing desquamated scales fresh from a case of measles into the denuded skin of a susceptible subject. It is unwise, however, as abundant clinical experience testifies, to disregard the element of contagion until all desquamation has ceased, and clothing, utensils, and apartments have either been disinfected or exposed to fresh air and sunlight for at least a day.

Susceptibility to the contagium of measles is almost universal, and few escape after direct exposure unless protected by a previous attack. People differ, however, as to susceptibility, some contracting the disease by a very short exposure, while others require more intimate or protracted contact. Naturally where apartments are ill ventilated, and many patients are confined in one room, the danger of communicating the disease is greater than where proper hygienic measures are carried out. Thus, in schools, kindergartens, and asylums the greatest danger of infection exists. One attack, however, usually confers immunity for life. Second attacks of measles are exceedingly rare, and in this respect it does not differ from that observed in variola, scarlet fever, and varicella. Third attacks, as in the other exanthemata, have been recorded, though this must be looked upon as a great rarity. Such cases have been reported by Van Dieren and Bierbaum (cited by Thomas). Most instances of apparent relapse, or so-called second attacks, are, in reality, cases of roseola, or German measles, as the latter may readily be mistaken for measles, and in the author's experience many cases supposed to be second attacks of measles were found to belong to the erythematous group. This is in conformity with the opinion expressed by nearly all who have had a wide experience with the disease. Thomas (*loc. cit.*) cites Rosenstein (1789), who devoted the closest attention to eruptive diseases during a period of forty-four years without encountering a second attack of measles in the same person. Willan (*loc. cit.*) did not meet with a single instance in which measles occurred a second time accompanied by fever. Panum,[534] from an immense number of observations, has not reported a single case in which measles occurred the second time. Thomas, in his extensive experience, has not met with a single case. There are good grounds for believing that error has occurred in many cases apparently contradicting such an array of experience. Second attacks

[534] Panum: Virchow's Archiv, i, 1848.

of measles may, however, occur, as has been stated. Most of the authentic cases on record have occurred either a few weeks after the original attack or after several years.

No age is wholly exempt, although measles is less commonly seen in infants under one year of age and in old people. According to Mayr (*loc. cit.*), of 10 nurslings exposed to measles, 1 only contracted the disease. In an epidemic in the Foundling Hospital at Bordeaux Barbillier[535] reports, of 33 children between one and seven years of age, 24 were attacked, while of 40 children under one year of age only 7 were attacked. On the other hand, when measles is introduced into a previously non-infected community, all ages and both sexes are attacked. Thus, in the Canary Islands measles had been wholly absent for a period of at least sixty-five years previous to 1846, when an infected person landed, infecting 6000 of the 7782 inhabitants. Why measles is seldom seen in adult life may be readily understood when we consider how few children escape exposure. In most countries measles is endemic, although epidemics occur at frequent intervals. Few, therefore, escape infection in early life. It is most commonly met with between two and ten years of age, although the contagium may be transmitted to the child *in utero*.[536] Thomas (*loc. cit.*, p. 50) has collected six instances in which the exanthem of measles was present at birth. After citing several cases of measles appearing a few days after birth in children whose mothers had contracted the disease just previous to delivery, von Jürgensen (*loc. cit.*, p. 44) draws the conclusion that the virus is conveyed through the placental circulation. On the other hand, Thomas cites an instance of measles occurring in a mother at the fifth month of gestation in which the fœtus was not affected, as it had the disease at the age of nine years at the same time with its brothers and sisters. Finally, measles has been reported at the age of 80 (Drake) and at 83 (Michaelson). The disease is more prevalent during the cool than during the warm months, and in the United States most cases occur during the autumn and spring months. More cases are reported during March, April, and May than during the corresponding autumnal period. Whitelegge,[537] after carefully compiling statistics in Great Britain, believes the interval between epidemics is

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[535] Barbillier (L.), cited by Thomas, p. 49.

[536] Ballantyne (J. A.): "Congenital Measles, with Note of a Case." Archives of Ped., April, 1893.

[537] Whitelegge: Brit. Med. Jour., 1893, vol. I, p. 451.

about two years. Again, about once in ten years an epidemic of unusual severity occurs accompanied by a high rate of mortality. In some decennial epidemics double or even treble the ordinary mortality may be observed. In Great Britain and on the continent of Europe two yearly maxima are reached at the beginning of winter and at the beginning of summer.

All races seem likewise susceptible to the disease. It is generally observed that, when measles is introduced into a country or community previously free from the disease, it appears with unusual severity. Thus, among the Indians of this continent it was greatly dreaded.

According to Bard (*loc. cit.*), broncho-pneumonia is usually a secondary or additional infection, but it may co-exist with the morbilli, in which case it manifests a mixed infection.

It is claimed by some that measles may attack certain animals, and the experiments of Behla,[538] in which he inoculated a young pig with secretions from the mouth and nose of a case of measles, seems to prove this assertion. In this case there appeared four days later a discharge from the nose and the catarrhal symptoms of the eyes such as observed in the prodromal stage of measles in the human subject. On the fifth day the animal was observed to be ill, and with loss of desire for food and marked shivering; the temperature soon rose to 103° F. (39.4° C.). On the eight day on the muzzle, cheeks, and ears, together with other parts, partially devoid of hair about the head and neck, there were found reddish spots. This extended, in the course of twenty-four hours, over the whole body. In appearance this resembled the rash observed in human measles, and was followed by desquamation. Fourteen days later an adult pig which had come in contact with the one inoculated came down with the disease, which lasted about four days, terminating in a slight desquamation as in the one preceding. Seven days later another pig belonging to the same sty had a similar attack. It was regarded as swine fever, although an examination of the blood and mucous secretions did not reveal the bacillus found in this disease. Josias[539] repeated Behla's experiments with a negative result. Similar eruptions have been seen in sheep and dogs, and recently Chavigny[540] has observed measles in an ape. Until we ascertain the specific cause of measles it is difficult to draw definite conclusions as to the character of the eruptions here cited.

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[538] Behla: Centralb. f. Bakt. und Parasit., xx, 16 und 17.
[539] Josias: La Méd. Mod., No. 20, 1898.
[540] Chavigny: Bull. Méd., Paris, 1898, 12, p. 334.

DIAGNOSIS.

The epidemic character of measles renders a valuable aid in diagnosis and in determining the nature of a suspected case; at the same time one must not lose sight of the fact that sporadic cases occur from time to time, and, when isolated or when susceptible people are not exposed, its contagious or epidemic nature may not be disclosed. However, the diagnosis of measles is usually not difficult when one bears in mind and understands the relative importance of the various symptoms that have been already detailed. Furthermore, it is especially important, on account of the variations which are known to take place, to rely more on the general *ensemble* as revealed by a careful examination than on any one symptom or even set of symptoms alone. Thus the prodromal period often presents departures from the normal, and later the rash in measles may be closely simulated by other affections totally dissimilar in character. The early recognition of measles is of the highest importance, because the disease is contagious as soon as the prodromal symptoms appear, and it has been conclusively shown that in the majority of cases infection occurs during the prodromal stage.

Influenza.—At this time the affection most commonly mistaken for measles is influenza or simple coryza. The mother recognizes in the symptoms of measles during the first twenty-four hours the usual phenomena of a "common cold," while, on the other hand, the epidemic feature of influenza is liable to confuse the medical attendant, and, should erythematous lesions of almost any form supervene, an error in diagnosis is frequently made. In all cases the wisest course is to isolate the patient so far as practicable until the further development of the disease enables the physician to form an intelligent opinion as to its nature. The inexperienced too frequently err in attempting to make a diagnosis without sufficient deliberation and without waiting for the establishment of a sufficient number of distinctive symptoms. Under such circumstances it is the duty of the physician, and one which will redound to his own credit, to explain to the family that the disease has not sufficiently developed to warrant an opinion as to its name, but that precautions against exposing others should be taken until its true nature is revealed. During the first day the main considerations are as to the prevalence of an epidemic and whether or not the patient has been exposed to any contagious disease. In influenza the rise of temperature is less marked than in measles, and there is less photophobia. Vomiting is rare in influenza and common during the

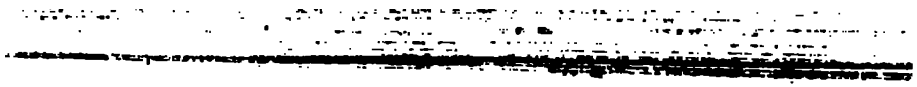
prodromal stage of measles. On the second day and sometimes even on the first the buccal mucous membrane usually affords positive diagnostic signs. In influenza the mucous membrane of the mouth is ordinarily normal, the pharynx and tonsils are usually reddened and the latter often swollen, while in measles the whitish-blue color of the inner surface of the cheeks and lips, together with the dark-reddish spots, speckled with whitish, vesicle-like bodies,—the enanthem of measles,—may in most cases be recognized. On the third day the enanthem continues to develop, while the fever and other symptoms may subside. There should be no delay in establishing strict quarantine with the appearance of these pathogenic symptoms, although unfortunately the physician is seldom called until exposure has already taken place.

Rubella, or German Measles.—With the appearance of the rash on the skin and during the course of the exanthem, rubella is undoubtedly more frequently mistaken for measles than any other disease. The differential diagnosis between these affections will be fully considered under "Rubella."

Scarlet Fever.—The early differentiation between measles and scarlet fever is of less moment than between measles and certain other affections, especially those of a non-infectious nature. Moreover, measles is liable to be mistaken for scarlatina only in special cases. At the outset there may be anorexia, vomiting, drowsiness, or irritability and a rapid rise of temperature in both diseases, but in scarlet fever the congestive disturbance of the mucous membranes is mainly confined to the pharynx, tonsils, and larynx, with less photophobia or dread of light so common in measles. In scarlet fever there is tenderness about the neck, with pain on palpating the submaxillary glands, which are frequently swollen, while in measles these are replaced by a more general catarrhal condition of the upper air-passages, giving rise to coryza and a dry, barking cough. The tongue in scarlet fever soon becomes reddened at the tip and margins with swollen papillæ projecting,—the "strawberry tongue,"—while in measles it either remains covered with a whitish fur or becomes red with a few enlarged papillæ which appear at a later stage of the disease. The buccal mucous membrane in scarlet fever is of a bright-reddish tint, with the uvula greatly injected, while in measles the pale-bluish tint, together with the characteristic enanthem, are usually sufficiently distinctive to differentiate between them.

The duration of the prodromal stage should likewise be taken

PLATE XXXIX.



XXXIX

RUBEOLA—showing grouping of the lesions.

PLATE XL.

XL

RUBEOLA—the eruption becoming confluent on the chest, resembling somewhat the eruption of scarlet fever.

into account: in scarlet fever twenty-four hours or less, seldom longer, while in measles the rash does not appear until the fourth day. Usually the bright-red, punctate eruption of scarlet fever is quite unlike the cyanotic features and dark-red maculæ of measles, but in individual cases it must be admitted some difficulty may be experienced in differentiating them. This is less so, however, than between German measles and scarlet fever, which frequently closely simulate each other. In scarlet fever, while the exanthem may consist of distinct lesions with normal integument intervening, yet the spots are smaller and tend to the punctate form. On the other hand, the lesions may coalesce in measles, forming wide areas of the eruption; still, at the margin and on other parts of the body there will be found those which adhere to the measles type. (See Plate XXXIX.)

Erythema, Roseola, Nettle-rash, and Prickly Heat.—In young children these are often accompanied by more or less digestive disturbances, yet the catarrhal symptoms of measles are absent and there is little or no constitutional disturbance. The temperature remains normal, or at most is but slightly elevated, and then only for a short time. The rash may resemble that of measles in some of these cutaneous disorders, but it never appears in the order observed in measles. Erythema most frequently appears on the back of the hands, forearms, and feet, while simple roseola is often limited to the face, or extends only to the neck and chest, rarely over the whole body. Furthermore they are of short duration and the latter quite evanescent. The lesions in erythema are usually larger, sometimes forming more or less extensive *plaques*, while roseola simulates more closely the deep blush of scarlet fever. The entire absence of constitutional symptoms and coryza are sufficient to distinguish the rashes due to excessive perspiration and the irritation produced by flannel or other rough clothing.

Drug Eruptions.—Certain drugs are known to produce rashes of various kinds, and when given for some slight febrile disorder, as in influenza and "colds," there sometimes appears a condition which may readily be mistaken for measles. This illustrates the importance of obtaining a correct history of the case, and especially when called after the disease is well advanced, before making a diagnosis. The drug eruptions most liable to be mistaken for measles are those of *quinine* and *antipyrin*, because these drugs are most commonly employed in disturbances simulating the prodromal stage of measles. Thus, in an analysis of sixty cases of quinine eruption, Morrow[541] found thirty-eight were

[541] Morrow (Prince A.): "Drug Eruptions" (New York, 1887).

of the erythematous form. In most cases it appears as an efflorescence of a bright, vivid hue, which disappears on pressure and closely resembles the rash of scarlatina. Less frequently the color is of a darker hue, and it appears in the form of distinct red spots, which may become confluent or patchy, when it closely resembles the exanthem of measles. Usually it appears first on the face and neck, after which it soon becomes diffused over the whole surface of the body. In exceptional cases or when the drug has been discontinued, it remains limited to face, upper part of the chest, or arms. Upon discontinuing the drug the eruption quickly disappears, and, as in both scarlatina and measles, is followed by a branny, or lamellar, desquamation. The mere fact that the administration of quinine is sometimes followed by a rash should guard against its being mistaken for measles. If any doubt exist, a prompt discontinuance of the drug would enable one to accept or exclude the administration of quinine as an etiological factor. Ernst[542] was the first to recognize the close resemblance between the rash of antipyrin, which he observed in five cases, and that of morbilli. In the cases thus reported the rash appeared on the trunk and extremities, as well as on the palmar and plantar surfaces. Antipyrin as usually observed gives rise to an erythematous eruption having its seat of predilection on the chest, abdomen, and back; rarely on the face and neck; and only occasionally on the extremities. Next to quinine, it is more liable to be mistaken for the rash of measles than any other drug efflorescence: first, because it usually accompanies or follows an elevated temperature, for which the drug has been given; second, because the individual lesions bear a close resemblance to those of measles. It may appear after the administration of a single dose, and consists of small, irregularly circular, slightly elevated reddish blotches, which may either be discrete or confluent, forming large patches of various shapes and sizes. The absence of the efflorescence on the face and neck, together with the freedom from the catarrhal symptoms of morbilli, will usually enable the physician to differentiate between them. Antipyrin never gives rise to the peculiar buccal enanthem of morbilli.

The internal administration of *chloral* is sometimes, though rarely, followed by an efflorescence of the skin. It appears in the form of a diffused, bright redness of uniform character, which first shows on the face and successively becomes distributed over the neck, chest, and extremities, with a special predilection to affect the integumental

[542] Ernst: Centralb. f. klin. Med., 1884, No. 33.

covering of the joints, notably the knees, wrists, elbows, and ankles. On the face it most frequently becomes manifest as a diffused redness, while on other parts of the body it consists of dusky-red spots or patches of various sizes, irregular in outline, which give to the skin a mottled appearance. As pointed out by Morrow (*loc. cit.*), the efflorescence becomes more pronounced after the ingestion of food or alcohol, and sometimes recurs after each meal for some time after the discontinuance of the drug. The absence of all catarrhal or suffusive disturbances of the conjunctivæ and upper air-passages would readily enable one to exclude morbilli.

When "balsams" were administered *per oram* in the treatment of urethritis, it was not unusual to see a measles-like eruption following the use of *cubebs* and *copaiba*. As these drugs are seldom administered to children, and as the peculiar balsamic odor attending their use is readily detected, there is little likelihood of their being mistaken for the exanthem of measles. However, as this has occurred, it may be well to mention some of the principal points of distinction: The rash following the use of both copaiba and cubebs varies somewhat in character, but generally appears in the form of reddish spots of a bright color, varying from a split pea to a dime in size, separated by normal skin, although at times coalescing and forming irregular patches of a considerable size. The lesions disappear on pressure, as in measles; they are not, however, elevated above the level of the skin as in the latter disease. Finally, the strong tendency to appear around the articulations of the extremities is especially noteworthy, and serves to distinguish the drug eruption from the exanthem of measles. Sometimes, however, the efflorescence appears on the face and neck, when they bear a closer similitude, and it is in these cases that mistakes are usually made. No changes are observed in the mucous membranes.

Various Other Less Frequent Sources of Error in the Diagnosis of Measles.—Numerous other cutaneous disturbances might be mentioned which in themselves bear a more or less striking resemblance to the rash met with in measles. It is only in very exceptional instances, however, that any uncertainty need exist in their differential diagnosis. Thus, the bites of insects, especially *bed-bugs*, *fleas*, and *mosquitoes*, sometimes produce, in children possessing delicate or susceptible skins, an eruption which at first sight might arouse a suspicion of measles. Their sudden appearance, however, unaccompanied by any general disturbance, should serve to exclude an infectious constitutional disease like measles.

Again, the symptomatic roseola or erythema which sometimes precedes *typhus fever*, *cholera*, and other affections may occasion some uncertainty, although this is possible for a short time only, as the probability of measles will soon be eliminated by the subsequent course of the disease.

The prodromal roseola of *small-pox* and its differential diagnosis from measles has already been treated of under the former disease.

The rashes following the injection of *antitoxin serum* in diphtheria and *antistreptococcic serum* may simulate the rash of measles; but, again, the constitutional symptoms are usually so dissimilar that the mere knowledge that such efflorescences sometimes follow the use of these substances should be sufficient to insure safety from a diagnostic stand-point.

In *syphilis* the early eruption, which is of a mottled or macular character, may present a blotchy or "measly" appearance. Further, the mucous surfaces in syphilis participate in the general efflorescence. Syphilis usually occurs in young adults, while measles is, for the most part, a disease of childhood. Furthermore, during the early stage of syphilis the initial lesion is usually still present, or an indurated scar indicating its former site offers a valuable diagnostic guide. It is only when syphilis is acquired in childhood that the two eruptions are liable to be confounded. In this case the general symptoms are sufficiently distinctive to readily distinguish between them when ordinary care is taken. The absence of fever and coryza in syphilis, together with its slow course, offers sufficient contrast to the acute catarrh and febrile prodrome of measles. Again, *aphthous stomatitis*, frequently associated with anorexia, irritability, and fever, must not be mistaken for the enanthem of measles. It may be observed that the aphthous spots are much larger, are of a more yellow or wash-leather color, and soon ulcerations appear.

In the *dark-skinned* and *colored races* the characteristic cutaneous exanthem is modified and may afford little assistance in diagnosis. In the Malay and North-American Indian the eruption presents a marbled appearance or occurs in irregularly shaped coppery blotches. This is followed by desquamation, as in the Caucasian. Negroes present slightly mottled, elevated, or lichen-like *plaques*, which are best recognized by the touch, and later by a whitish desquamative condition of the skin. Of the greatest value in this class of cases are the changes observed in measles in the various mucous membranes. These, with the rise of temperature and general symptoms complained of, must be

relied upon in arriving at a conclusion as to the nature of the disease.

Measles without exanthem presents even greater difficulties, and probably would not be recognized in the absence of an epidemic or other well marked cases in the immediate vicinity. The prodromal symptoms must be taken into account and the condition of the mucous membranes, which, with the characteristic lesions in the buccal cavity, will, in the majority of cases, enable the physician to recognize the disease even when the exanthem is absent. As yet the claims of Bolognini, previously mentioned, relative to the value of peritoneal crepitation as a diagnostic aid, have not been sufficiently verified. Fortunately in many cases there is a rudimentary or abortive rash about the face and neck, which, with the usual symptoms, will enable a diagnosis to be made with certainty.

PROGNOSIS.

Measles pursuing a normal course and when uncomplicated with other diseases seldom ends in death. The complications of measles, on the other hand, are exceedingly grave, both as to life and to the more or less permanent impairment of the general health or of special organs of sense. The conditions which tend to the development of certain diseases during the course of measles, and the liability to various complications and anomalies which militate against a favorable prognosis, are: the age of the patient; various influences which impair the general health, such as unhygienic surroundings and overcrowding; the predisposition to, or presence of, tuberculosis or the strumous state; and the severity of the prevailing epidemic. Fortunately infantile susceptibility to measles is far less than obtains later in childhood and adolescence. Even when it does occur during the first six months of life it is often mild and clinically presents a strong resemblance to rubella. After this period and during the first dentition the susceptibility to the affection increases, while the fatality becomes correspondingly high. The greatest fatality is met with under two years. This is in accord with the observation of clinicians both in this country and in Europe. After studying the disease in a large number of cases and during many epidemics, Holt (*loc. cit.*, p. 923) estimates the fatality of measles in children of all ages to be from 4 to 6 per cent., while under two years of age it is frequently 20 per cent. or even more. According to Williams (*loc. cit.*), there occurred in England and Wales 367,602 deaths attributed to measles during the forty years from 1848 to 1887. Of this number 335,874 were in children less than five years

of age, leaving only 31,728 to be distributed among those of five years of age and older. Under five years of age the distribution is shown in the following table, which is taken from his valuable article:—

Under	1	year,	male	3.01	deaths	per	1000	living	at	that	age.
"	1	"	female	2.51	"	"	1000	"	"	"	"
1	to 2	years,	male	5.81	"	"	1000	"	"	"	"
1	" 2	"	female	5.46	"	"	1000	"	"	"	"
2	" 3	"	male	2.88	"	"	1000	"	"	"	"
2	" 3	"	female	2.93	"	"	1000	"	"	"	"
3	" 4	"	male	1.60	"	"	1000	"	"	"	"
3	" 4	"	female	1.68	"	"	1000	"	"	"	"
4	" 5	"	male	0.93	"	"	1000	"	"	"	"
4	" 5	"	female	0.96	"	"	1000	"	"	"	"

These statistics, while they do not show the percentage of deaths to the whole number of cases at the various periods mentioned, serve to show that, while measles is very prevalent before the semidecennium, its fatality decreases greatly after the second year of life.

Gaunelon[543] reports the mortality of measles at the Hôspice des Enfants Assistés in Paris during the five years from 1887 to 1891 as follows:—

0	to	6	months,	23.68	per	cent.
6	"	12	"	55.77	"	"
1	"	2	years,	53.94	"	"
2	"	3	"	27.73	"	"
3	"	4	"	13.66	"	"
4	"	5	"	6.20	"	"
10	"	20	"	*nil.*	"	"

The anomalies of measles are shown by Kellner,[544] of Frankfort, to be more frequent during the periods when the highest mortality prevails: thus, of 18 cases during the first year of life, 44 per cent. were anomalous; of 61 during the second year, 52 per cent.; of 84 during the third year, 34 per cent.; of 168 during the fourth and fifth years, 21 per cent.; of 204 during the sixth to tenth years, 21 per cent.; of 34 during the tenth to fifteenth years, 20 per cent.; of 11 during the fifteenth to twentieth years, 18 per cent., and of 22 above twenty years, 10 per cent. were found to be anomalous.

According to Spiess,[545] the percentage of anomalous cases is highest during the second year of life (42 per cent.), after which it de-

[543] Quoted from Dawson Williams (*loc. cit.*). Gaunelon: "La Rougéole à l'Hôspice des Enfants Assistés" (Paris, 1892).

[544] Taken from Thomas (*loc. cit.*).

[545] *Ibid.*

creases rapidly, touching the lowest point (4 per cent.) at the twentieth year, increasing again after this age until it reaches 20 per cent. in later life.

Again, the greatest fatality is met with in cities, asylums, and nurseries. According to Williams, the mortality of measles seems to be unaffected by improved sanitation, in substantiation of which he cites the reports of the Local Government Board[546] of England and Wales, showing an increasing mortality since the decade ending 1880, while the principal zymotic diseases which are more directly dependent on sanitation have materially decreased. This does not conform to the experience of the present writer. The death-rate from measles taken, for the most part, from the worst possible conditions, namely: the hospitals and asylums of cities. In an epidemic which occurred in Heidelberg Fürbringer[547] gave the death-rate in cases treated at the Poliklinik at 6.7 per cent., while in private practice it was only 2.6 per cent. In the Nursery and Child's Hospital, of New York, Adriance (*loc. cit.*) reports 96 cases with a mortality of 15 $^{5}/_{6}$ per cent., and the report of the New Hampshire State Board of Health shows that measles has been the direct cause of two hundred and sixty deaths during the past twelve years.[548] Among cases well cared for in private families with healthful surroundings the mortality even in cities is far less than these statistics show, while in the country the prognosis at all ages is good.

Naturally the depressing influence of measles on those of debilitated constitution influences the prognosis very materially. The most frequent complication, pneumonia excepted, has been shown to be tuberculosis. When this disease already exists in a latent state it is almost certain of assuming an active if not rapidly fatal form during an attack of measles. The immediate prognosis is dependent largely on the organ affected. Thus, in the superficial lymphatic glands it is less fatal than when in the lungs or meninges of the brain or spinal cord. Those having chronic thoracic affections are especially endangered from an attack of measles.

Again, chronic catarrh is always greatly aggravated during the congestive process of the prodromal stage. When delicate organs are involved, as the structures of the middle and internal ear, either an impairment or total loss of function or even death is imminent.

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[546] Thompson (Theodore): "Twenty-fourth Annual Report of the Local Government Board, with Supplement," v, 1894-95.

[547] Fürbringer: Berliner klin. Woch., 1891, S. 103.

[548] New Hampshire Sanitary Bulletin, Jan., 1900.

The greatest care should therefore be taken to guard strumous or anæmic children against the infection of measles. Those suffering from chronic otitis or bronchitis should on no account be exposed to the disease. The prognosis is likewise unfavorable in hydrocephalic children, or those subject to convulsions. Since it is well known that the mortality of measles is highest before the third year of life, children under this age should be assiduously protected from exposure. Statistics in all countries show conclusively that epidemics vary greatly in severity. Those cited by Thomas (*loc. cit.*, p. 114) may be given as bearing especially on this point. In 1856 an epidemic of measles broke out in Lippe, Hungary, which gave a mortality of 50 per cent. In this epidemic the prodromal stage was normal, but after the fifth day complications were frequent. Seven years later, 1863, another epidemic occurred in the same town with a mortality of only 3 per cent. Nor can this be attributed to the season of the year in which the epidemic occurs. In 1862 Karajan[549] observed an epidemic of measles in lower Austria during the cool months, which are supposed to be the most unfavorable, in which the mortality was 2.29 per cent., while in the same district during the following summer it attained a fatality of 6.29 per cent. According to Voit,[550] during a period of thirty years, the mortality of measles during the winter months at the children's clinic at Würzburg was 12.7 per cent.; during the spring months it was 11.5 per cent., while in the summer a fatality of only 2.5 per cent. was recorded. An epidemic of great severity broke out in Sunderland, England, in 1885, in which Harris[551] states that no previous record in the history of the borough shows an epidemic of equal severity. Of 1316 known cases, 384 deaths occurred, or over 29 per cent. During the ten years preceding, the average number of deaths *per annum* from measles was 46, and the percentage of mortality was said to be very low, although the number of cases that occurred is not given. In 1887 there occurred in Liverpool and vicinity an epidemic which was considered of unusual severity, having a mortality of 15 per cent. In striking contrast was the epidemic which occurred in the Canary Islands in 1875, in which, of 1123 attacked with measles, only 8 died. Measles seems to be severe and accompanied by an uncommonly high mortality among certain savage or semibarbarous peoples. From accounts of the ravages it produced

[549] Karajan, quoted from Thomas (*loc. cit.*, p. 115).
[550] Voit: *Ibid.*
[551] Harris: Lancet, April 30, 1887, p. 970.

among the American Indians one can appreciate the great dread the disease inspired. Since the introduction of measles among the Fiji Islanders in 1874 no contagious disease is said to be more feared by the natives of the Pacific Islands, the death-rate not infrequently reaching as high as 30 per cent. It is thought by some who have observed their mode of managing the disease that exposure and surf-bathing account for the high mortality there recorded. Doubtless exposure to inclement weather, at which time measles is usually most prevalent, accounts for its great fatality among the American Indians.

From the foregoing it is evident that the prognosis depends on numerous influences, which vary greatly at different times and in different countries. Unquestionably broncho-pneumonia complicating measles is the cause of the majority of deaths. According to von Jürgensen (*loc. cit.*), broncho-pneumonia complicating measles in childhood carries off approximately one-third of those attacked. On the other hand, measles is one of the least fatal of the infectious diseases (exanthemata) when reasonable care is taken and when the environment of the patient offers a fair degree of immunity to extraneous infection. In individual cases the prognosis is good when the fever diminishes after the full development of the exanthem, while with a receding eruption, the temperature remaining high, a guarded prognosis must be given. With an irregular elevation of temperature continuing during the period of desquamation, tuberculosis should be suspected. Croup and diphtheria when complicating measles likewise render the outlook exceedingly grave. Diarrhœa, when severe, and the supervention of hæmorrhages either into the cutaneous lesions or from the serous or mucous membranes should always be looked upon with apprehension. When the exanthem is confluent over the whole body and assumes a bright or vivid redness the termination is uncertain, and when it persists several days after full efflorescence it is especially ominous, and grave complications may be expected. According to Thomas, death usually takes place on the second, and rarely during the first, week of the disease.

In pregnant women measles usually follows a normal course, and the prognosis is favorable. When unusually severe or anomalous, premature expulsion of the fœtus ensues, and death of the mother is not uncommon. This usually occurs at the time the rash appears. Intrauterine infection sometimes occurs, when the child presents an eruption at birth or the disease develops soon after. The greatest danger to the mother is from broncho-pneumonia and septicæmia.

TREATMENT.

The management of measles is threefold: it embraces, first of all, prophylaxis; second, the task of conducting the disease to a favorable termination; and, third, the treatment of such complications as may arise.

Prophylaxis.—It has been shown that the restriction and absolute control of measles is not only feasible, but highly to be desired as a means of public safety. By strict quarantine the disease has been eradicated from certain communities, which have enjoyed complete immunity during long periods. The greatest obstacle to the segregation of measles arises from the fact that in itself it is a mild affection and the public are indifferent, not only about promptly reporting it to the health authorities, but of efficiently carrying out the necessary restrictions against its spread. In this country it is not long since measles was allowed to prevail, and parents sometimes willfully exposed their children, believing that sooner or later they must have the disease. In the light of modern sanitation this has been conclusively shown to have caused the sacrifice of innumerable lives and to have destroyed in others the organs of hearing. Again, its infectious nature during the prodromal stage, before the family, or even the medical attendant, realizes the danger to which others in the immediate vicinity are exposed, renders its prevention a perplexing problem for boards of health to solve. Moreover, in the absence, or at the beginning, of an epidemic the symptoms are often not sufficiently distinctive to warrant a prompt and positive diagnosis before exposure to the susceptible has already occurred and an epidemic is inevitable. The distribution of literature among teachers and others bearing on the spread of contagious and infectious diseases is highly to be commended, for in this way the public may become instructed and a proper appreciation of its duty engendered. Valuable contributions on this subject have been made by Thomson (*loc. cit.*), Kenwood,[552] and Baker,[553] to whose writings the student of preventive medicine may profitably turn.

The establishment of boards of health in most States has likewise done much to control the spread of the infectious diseases.

In preventing and limiting the spread of all infectious diseases the first step is to secure the intelligent co-operation of the public at

[552] Kenwood: Journal of the Sanitary Institute, London, vol. xviii, p. 161.

[553] Baker (Henry B.): Secretary of the Michigan State Board of Health, "Reports and Leaflets on the Prevention and Restriction of the Infectious Diseases," etc., 1900.

large. In addition to the method suggested, every member of the medical profession should realize the great responsibility resting upon him, and lend a hand by instructing the people and reporting to the local boards of health all cases of known or suspected infectious diseases at the earliest possible moment. It should be conspicuously set forth that *measles is contagious*, that it is *dangerous* to life, that it is *one of the most frequent causes of deafness*, and as such is a constant menace to the public health. The annual mortality from measles in London, according to Quain,[554] is nearly 5 for every 10,000 inhabitants. In 1889 the deaths from measles (14,732) in England and Wales were 5 per 1000 inhabitants, and exceeded those from both scarlet fever (6698) and diphtheria (5368). According to Russell,[555] the deaths from measles in Glasgow during five years (1891-96) were three times as many as those caused by scarlet fever, four times as many as enteric fever, and only one infectious disease, whooping-cough, was more destructive to life. In the State of Michigan the deaths from measles that were reported to the board of health were, according to the secretary's report, several times as many as from small-pox, and for eighteen years previous to 1888 averaged 157 *per annum*. Further it has been shown that it is *one of the most dangerous diseases to which a child under five years of age can be exposed*; that *it is especially dangerous during teething*, or the second year of life, death often resulting from inflammation of the lungs; and that the longer a child can be protected from measles the less liable it is to become deaf or to die from the disease. During the seventeen years preceding 1888, 71 per cent. of all deaths from measles in the State of Michigan were of children under five years of age, while between the ages of ten and twenty it was only 8.1 per cent. In delicate or strumous children *measles often leads to consumption. It is not true* that *having* the *children's diseases while young predisposes* to or *assures better health in after years*, as many believe.

A leaflet issued and distributed gratuitously by the Michigan State Board of Health (February, 1900) gives the following:—

"HOW TO AVOID AND PREVENT MEASLES.

"Avoid the special contagium of the disease. Do not let a child go near a case of measles; this is especially important to be observed

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[554] Quain's "Dictionary of Medicine" (London, 1883).

[555] Russell (J. B.): Hand-bill issued for the Glasgow Health Committee, 1897. Quoted from Dawson Williams (*loc. cit.*).

by guardians of children between one and two years of age. Do not permit any person or thing, or a dog, cat, or other animal, to come direct from a case of measles to a child. Unless your services are needed, keep away from the disease yourself. If you do visit a case, bathe yourself and change and disinfect your clothing before you go where there is a child.

"Do not permit a child to ride in a hack or other closed carriage in which has been a person sick with measles, except the carriage has since been thoroughly disinfected.

"Do not permit a child to wear or handle clothing worn by a person during sickness or convalescence from measles.

"Beware of any person who has a cough or sore throat; do not permit a child to kiss or take the breath of such a person, nor to drink from the same cup, blow the same whistle, or put his pencil or pen in its mouth."

It is incumbent on teachers and others having the care of children to recognize as suspicious the early symptoms of measles, and they should be informed that the *disease is contagious before the rash appears*, and *continues so for three or four weeks thereafter*; that children having the appearance of a *cold in the head with smarting of the eyes and dread of strong light* should be isolated, and if at school sent to their homes, until the nature of the disorder can be ascertained.

Many physicians are loath to subject their clients to the inspection of the health authorities, and to the inconveniences of possible quarantine, until contagion is scattered broadcast and prevention is impossible. The law in Ohio and in most States compels the attending physician to report any infectious disease within twelve hours after becoming aware of its nature to the board of health within whose jurisdiction such person is found. Unfortunately the clause "*after becoming aware of its nature*" often means, in the author's experience, within a week or two after the onset of the disease. Furthermore it is highly important that the executive officer of the health board, when such exists, should be well fitted for the responsible position he holds by thorough training and broad clinical study. With the political methods now in vogue this may seem Utopian. At least the services of a properly qualified person should, if possible, be secured in every county to investigate suspected cases. In most States the duties of the health officer are formulated, and penalties are imposed in case of neglect or violation of the same. The following is issued by the Michigan State Board of Health:—

"DUTIES OF THE HEALTH OFFICER.

"Some of the duties of the health officer, required by law, may be briefly suggested as follows: Whenever he has reason to believe that there is in his jurisdiction a case of measles, he should

"(*a*) Promptly investigate the subject.

"(*b*) Order the prompt and thorough isolation of those sick or infected with measles, so long as there is danger of their communicating the disease to other persons.

"(*c*) See that no person suffers for lack of nurses or supplies.

"(*d*) Give public notice of infected places by placard on the premises, and otherwise if necessary.

"(*e*) Notify teachers or superintendents of schools concerning families in which there are cases of measles.

"(*f*) Disinfect rooms, clothing, and premises, and all articles likely to be infected, before allowing them to be used by other persons than those in isolation.

"(*g*) Keep the president of his board of health and the Secretary of the State Board of Health constantly informed respecting every outbreak of measles.

"In the absence of regulations made by the local board of health conflicting therewith, orders by the health officers in the lawful performance of these duties have the force of regulations by the board of health.

"Unless otherwise ordered by the local board of health, these duties are required of the health officer by act which provides that—

"'Whoever shall knowingly violate the provisions of Section 1 of this act, or the orders of the health officer made in accordance therewith, shall be deemed guilty of misdemeanor, and upon conviction thereof he shall be punished by a fine not exceeding one hundred dollars, and the costs of prosecution, or in default of payment thereof, by imprisonment not exceeding ninety days in the county jail, in the discretion of the court.'

"This penalty seems to apply to the health officer or to whoever violates his orders. The health officer should also, in due time, give certificates of recovery and of freedom from liability to give measles; but not until after thorough disinfection following complete recovery."

At this time those having the care of the patient should be instructed either by circular from the board of health or by the physician in charge concerning the methods to protect others from con-

tracting the disease, for in most instances the execution of preventive measures is intrusted to the family medical attendant. On the appearance of measles, therefore, he should see that the house is quarantined and that due notice is given by means of a conspicuous card on the door stating the nature of the disease. If there are other children in the family they should not be allowed to attend school, church, or any other public function; especially should he see that they be prohibited from mingling with other children.

The secretions from the mouth, nose, and eyes should be removed by soft cloths, which should be immediately burned or otherwise disinfected. The excreta, urine, and fæces should be disinfected by chlorinated lime or other disinfectant and buried at least one hundred feet away from any well or dwelling. When sewer connection is at hand, a disinfectant should be thrown in after using and the basin thoroughly flushed. It is advisable to have disinfectants previously prepared and plainly labeled ready for use. (See formulary at end of volume.) For water-closets, vessels, etc., lime is one of the cheapest and most efficient, and may be prepared as follows: Chloride of lime (fresh), 1 pound; water, 3 gallons; Mix. A quart or more of this solution may be used daily in a water-closet, basin, vessel, or cuspidor. This may be diluted by adding 10 gallons of water to 1 gallon of the solution, when it may be used to disinfect sheets and other clothing used by the patient. It does not injure white clothing, and all such articles should be immersed in it for two hours before leaving the room. It may be said, further, that it is not poisonous and should be *used freely.*

Another efficient and inexpensive solution is made by adding, to 1 ounce of corrosive sublimate, 1 ounce of permanganate of potash and 8 gallons of water. It is non-odorous and is sometimes to be preferred in the sick-chamber on this account. It is less efficient than the chloride of lime for cess-pools, sink-drains, sewers, etc., and should not be used in metallic vessels. Further, it is poisonous and should only be used under the direction of the physician; but its bright-purple color will serve to distinguish it. Carbolic acid (1 part to 20 of water) may likewise be used about the sick-chamber when its odor is not objectionable. It is advisable that articles of clothing, sheets, etc., be laundried separately. After leaving the infected chamber the physician should cleanse his hands and spray his hair, beard, and clothing with formaldehyde (5 to 10 per cent.). He should, if possible, avoid coming in immediate contact with young children until after being exposed to the open air for an hour or more. Although instances are on record

in which infection is supposed to have been carried by physicians, letters, etc., yet it must be conceded that, considering the infrequency of this contingency, little danger really exists when ordinary precautions are taken.

After recovery the patient should be thoroughly bathed and clean clothing put on, after which he should be placed in an uninfected room. The apartments previously occupied should then be thoroughly disinfected by first immersing all washable articles of clothing, bedding, curtains, spreads, etc., in one of the disinfecting fluids to be mentioned, or subjecting them to boiling for half an hour, or hot air, 230° F. (105.05° C.). Fabrics such as carpets, books, and articles of furniture may best be spread out and subjected to the spray or fumes of formaldehyde, as given under room-disinfection at the end of the volume. It is also necessary to close all openings, cracks, and other communication with the outside air by packing with cloth or some other convenient substance. When less care of the furnishings warrants a cheaper disinfectant the sulphur-fumes may be used, full directions for which will be found at the end of the volume. Washing with corrosive-sublimate solution is equally effective. After fumigating about four hours the room should be opened, allowing the freest circulation of air possible and exposure to the sun's rays for about twelve hours. The apartments may then be considered free from danger. When death occurs, the body should be placed in a casket as soon as possible and 2 ounces of 20-per-cent. solution of formaldehyde sprayed on the clothing, after which the cover is to be securely fastened. It is highly desirable that but few persons attend the funeral, and only those who have previously had measles. Of great importance is the disinfection of public or circulating library books. This is best done by means of hot air or formaldehyde.

Although some of the measures recommended may be more vigorous than the feeble vitality of the contagium calls for, as previously shown, yet, as the life-history of the poison is not known, it is better to err on the side of safety. In the author's experience, little danger of contracting measles exists excepting in the immediate vicinity of the sick-chamber or in the intimate contact with those affected.

Management of the Disease.—Measles being a self-limited disease and when uncomplicated seldom giving rise to any serious consequences, its treatment naturally is mainly directed toward preventing complications.

Efforts have repeatedly been made to immunize against measles.

Thus, according to Williams (*loc. cit.*), Thompson inoculated nine children who had never had measles with fresh serum obtained from a blister on a patient suffering with the disease. In one or two days there appeared an eruption about the point of inoculation, which remained two or three days, bearing a slight resemblance to measles. In four children thus inoculated it was thought immunity was established. Weisbecker injected blood-serum from measles patients under the skin without obtaining any definite results. Hubert and Blumenthal employed serum from measles patients as a therapeutic agent in nine cases of measles. They believe it shortened the duration of the disease. The serum used was obtained from blood taken from convalescents and mixed with an equal part of normal salt solution, to which 1 per cent. of chloroform was added. This was then filtered through a Berkefeld filter. The results thus far have not given a positive assurance that either immunity or therapeutic value are to be obtained by this means.

Red light has also been used in measles with apparently good results. Thus, Chatinière[556] reports nine cases of measles which aborted in six hours in most instances. Not only the eruption disappeared, but the fever, laryngeal and bronchial manifestations were promptly attenuated, and recovery was complete in from three to five days after the first symptoms of the disease. It is also stated that the exanthem directly exposed to the red rays of light was the first to disappear.

As soon as the disease is recognized the patient should be placed in bed in a large, well ventilated room, as far as possible away from other children, care being taken that he is not placed in a direct draught, and that the air entering the room is pure. It is commonly observed that foul air tends to the aggravation of bronchial symptoms and to the development of broncho-pneumonia. Further, when the free circulation of outside air is prevented, the accumulation of carbonic acid in the inspired air retards its free elimination from the blood. Moreover, the greatest care should be taken that the intake of fresh air be not contaminated by smoke, dust, or the admixture of emanations from adjoining wards or decomposing matter. Particles of dust not only irritate the already inflamed mucous membranes, but serve as vehicles for various pathogenic micro-organisms, against which every precaution should be taken. In measles, therefore, the free circulation of pure air is imperative and in larger volume than is supplied to the other exanthemata. As commonly observed, however,

[556] Chatinière: Presse Méd., April 28, 1900.

there seems to exist a special predilection on the part of the laity to exclude the slightest ingress of the outside air, thus inviting the conditions most dangerous to life. Therefore, when other means of ventilation are not at hand, a window should be kept partly open day and night. Von Jürgensen (*loc. cit.*) is of the opinion that the danger of draughts in measles is greatly exaggerated. Dry air is likewise more irritating to the air-passages than moist air, besides favoring the diffusion of dust and various particles of extraneous matter, which may serve as the carriers of pathogenic bacteria. Therefore it is advisable to keep the air moist, which may be accomplished either by keeping a kettle of boiling water in the room or the frequent use of a fine spray. In the absence of a stove, sufficient steam can be generated by means of an alcohol-lamp. For this purpose the author has employed a spray composed of a 2-per-cent. aqueous solution of formaldehyde, which may be used freely about the chamber and over the bedclothing, care being taken not to cause undue irritation by its inhalation in a too concentrated form. This is often followed by an amelioration of the coryza, and serves as a disinfectant of the highest value.

Most rooms are kept too warm. The temperature should vary as little as possible, and in this country from 68° to 70° F. (20.0° to 21.1° C.) during the cooler months is found to be most acceptable. Another common error is to darken the room. While the direct rays of light should not strike the eye, it is advisable not to exclude the light entirely, as is so frequently done. If care be taken to place the bed with the head toward the window, little inconvenience is liable to be felt by the patient. When the sunlight is strong, thin curtains may be drawn to soften the sun's rays. At night there should not be a bright light in the room, but a shade should be so arranged as to produce the effect of twilight. Experience has shown that cases do best thus treated, as sunlight is known to be one of the most potent destroyers of disease-germs. Furthermore, no injurious effect on the eye is produced. On no account should the eyes be used for reading or other close work, until after complete recovery and strength is regained. Permanent injury to the sight may otherwise result.

Finally, the essential attribute, cleanliness, alike the prerequisite to the sick-chamber and hospital ward, must prevail. The attendants must be clad in washable fabrics, and not only be cleanly themselves, but they must see that the bed-linen and clothing of the patient are changed at frequent intervals. These must be immediately disinfected, and before leaving the room. The patient's body should be sponged

daily with tepid water. It is not enough that all discharges from the nose, eyes, ears, and secretions from the mouth and throat be removed on soft cloths and immediately burned, but the mouth and throat should be cleansed by using some mild disinfectant, such as a saturated solution of chlorate of potash, or boric acid. For other applications see "Addendum."

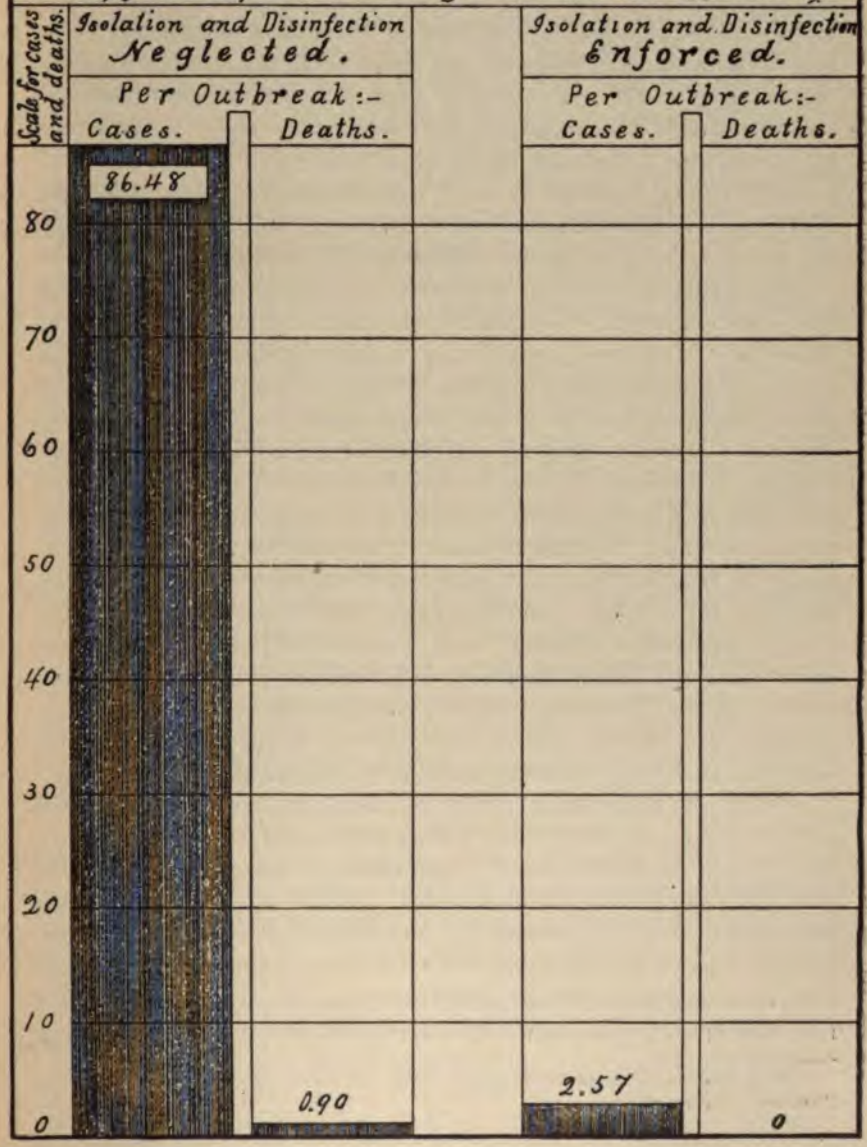
If marked conjunctivitis exists, the eyes should be flushed several times daily with a saturated solution of boric acid. Before handling the patient the nurse should see that her hands have been cleansed. For this purpose Formulæ Nos. 2 and 4 on page 376, will be found more efficient than the ordinary soap. It is convenient to have in the room a finger-bowl containing some toilet disinfectant, as Formula No. 3 at the end of the volume. There should also be provided a receptacle holding about four gallons, filled to within eight inches of the top with some disinfecting fluid, such as chlorinated lime, in which soiled towels, sheets, pillow-slips, night-clothes, etc., may be immersed before being sent to the laundry, or if more convenient they may be immersed in boiling water for half an hour. The most convenient is a solution of corrosive sublimate (1 drachm to a gallon of water—4.0 to 960.0), which should be kept in a crock or other earthen vessel, care being taken, when used in a private dwelling, that young children do not come in contact with it, and that it be plainly and conspicuously labeled *Poison*.

The patient should be kept in bed until after desquamation has taken place, which is usually about ten days from the first appearance of the prodromal symptoms. When practicable it is advisable to have two rooms adjoining, one to be used at night, the other during the day, the room vacant to be thoroughly cleaned and ventilated *ad interim*.

Some uncertainty exists in the minds of medical men concerning bathing during an attack of measles. While sudden chilling of the surface should be guarded against, the use of the tepid bath is not only grateful to the patient, but of actual value as a therapeutic measure. At the outset a full warm bath with soap should be given, and, during the course of the disease, sponging, exposing one part of the body at a time, or the full bath, should be used as the judgment of the medical attendant may dictate. To assuage the thirst, which is usually complained of, cool water may be given freely and at frequent intervals. Slightly acidulated beverages—such as weak lemonade, orangeade, or acidulated water made by adding a teaspoonful of phosphoric acid to half a pint of water—are usually craved, and may be given freely.

Isolation and Disinfection Restrict Measles.

Measles in Michigan in 1896:- Exhibiting the average numbers of cases and deaths per outbreak:- in all outbreaks in which Isolation and Disinfection were both Neglected; and in all outbreaks in which both were Enforced. (compiled in the office of the Secretary of the State Board of Health, from reports made by local Health Officers.)



The diet should be simple and suited to the age and general condition of the patient. At first there is anorexia, when nourishment in the form of milk, diluted with barley-water, may be taken with a certain degree of relish, or junket, oatmeal gruel, and beef-tea are well borne. Later in the course of the disease, soft-boiled or poached eggs, custards, rice, and toast may be added, but only as the appetite demands. Alcohol is seldom indicated in uncomplicated measles. As a substitute for alcohol, Semmola and Dujardin-Beaumetz[557] recommend 1 ounce of glycerin combined with about 8 ounces of water, and half a teaspoonful of citric or tartaric acid, to be given daily. Von Jürgensen speaks highly of strong Rhine wine, from $^1/_2$ to 1 ounce (20 to 40 centimetres), given fifteen to thirty minutes before and after the bath. When the cough is troublesome the throat may be freely sprayed with the mouth-lotion given in the "Addendum," or small doses of the wine of ipecacuanha, either alone or combined with tincture of aconite and syrup, are admirable. Good results have followed the use of iodide of potassium. Antipyrin in small doses is also recommended, as are the bromides of potassium and sodium. When the bowels are constipated, as not infrequently occurs during the prodromal stage, enemata should be given. Diarrhœa may be controlled by attending to the diet, by enemata, or by small doses of deodorized opium. This constitutes the treatment in a large majority of cases. Naturally variations must be made according to the circumstances of the individual case, and according as the treatment is conducted in a well-regulated hospital or in the dwellings of the poor. In the country, also, some ingenuity on the part of the medical attendant must be exercised to meet the requirements with very limited facilities. It is surprising, however, the good results that may be attained under what appear to be unfavorable circumstances, when the general principles of ventilation, asepsis, and segregation are fully understood and their value appreciated.

When an unfavorable course is imminent, one or more of the cardinal symptoms usually give timely warning, the most trustworthy being the temperature, which in all cases, however mild, should be carefully recorded night and morning. Although an unusually high temperature, which forebodes ill, may subside by prompt measures, and the case go on to an uneventful recovery, yet this is possible in most cases only when prompt measures are instituted. As pointed out, the fever seldom calls for therapeutic measures, but when the rise of

[557] Semmola and Dujardin-Beaumetz, cited by Montefusco: Rev. des. Mal. de l'Enfance, August, 1888.

temperature is rapid and excessively high, especially when continued, it should receive careful attention, as it is not infrequently the forerunner of some grave complication. In general, the usual antipyretics, such as antipyrin or phenacetin, are indicated. Only sufficient to reduce the temperature and allay restlessness is permissible. When the temperature reaches 103° F. (39.4° C.), antithermic measures should be used. When antipyrin is given to children it may be made more palatable by the addition of syrup. The best of all methods for reducing bodily temperature is by means of ice-bags, wet compresses, sponging, or baths. The judicious use of water as an antipyretic has long since been recognized as a safe and efficient agent by the medical profession, although the use of "water in fevers" has not altogether lost its terrors among the laity. When the fever is high and accompanied by delirium or other nervous manifestations, sprinkling cool water over the head and back of the neck is sometimes followed by marked relief. Cold sponging is one of the best means of controlling a moderately high temperature. Ice-bags made by inclosing small pieces of ice in a rubber bag and placed to the scalp or nape of the neck is even more prompt, and indicated in older children and adults with great irritability, convulsions, and delirium. Cloths dipped in cold water and applied may be employed when ice is not available. In very young children this should be applied for fifteen or twenty minutes at a time, and if necessary it may be applied continuously.

When compresses are used, they should be renewed at proper intervals. The full bath at a temperature of 95° F., gradually cooled to 75° or 60° F. (35° to 15.5° C.), is the most potent means of controlling the fever in malignant measles. It may be repeated at frequent intervals as the temperature rises, and may be accompanied by ice packs to the head. Juhel-Renoy and Duponchel[558] report excellent results with cold baths in the ataxo-adynamic forms of measles. Dieulafoy[559] gave cold baths in cases which were rapidly assuming a malignant form, in which improvement began after the fourth bath. The suppressed function of the kidneys was resumed and the patients went on to recovery. According to Fodor,[560] when the temperature rises higher than 102.2° F. (39.0° C.) baths should be given every hour, but one is sufficient during the night. After immersing the entire body in cold water,

[558] Juhel-Renoy and Duponchel: La Tribune Méd., May 15, 1890.

[559] Dieulafoy: La Méd. Mod., June 26, 1890. Quoted by Crandall in "Sajous's Annual," vol. iv, p. 541.

[560] Fodor (J.): Blätter f. klin. Hydrother., etc., July, 1891. Quoted by Crandall (*loc. cit.*).

the patient was rubbed with a sponge and afterward covered with towels wrung out of cold water. Even after the subsidence of the febrile action, baths, either warm or cold, may be continued at less frequent intervals.

Although disinfectants should not be employed indiscriminately to the general body surface, yet, when vesicles or small pustules appear, they should be kept as aseptic as possible. For this purpose a saturated aqueous solution of boric acid, or preferably an alcoholic solution with an excess of boric acid (Formula No. 5 at end of volume) may be used. This is usually soothing, and after evaporation leaves the fine boric acid powder deeply imbedded in the skin, and the odor is usually agreeable as counteracting the peculiar and sometimes offensive emanations from the patient. It is not intended that the entire surface shall be treated in this way, but only such regions as show a tendency to the development of the cutaneous lesions which sometimes lead to more serious complications. In foundling institutions, however, the patient and everything pertaining to him must be rendered as aseptic as possible. Hutinel[561] recommends that the child be given sublimate baths, and the nose and fauces be irrigated several times a day with sterilized water or a boric-acid solution. With the attention outlined in the foregoing the disease usually terminates with the completion of the desquamative process.

Treatment of Complications.—Since the anomalies and complications of measles present the most serious problems in the management of the affection, such possibilities should ever be in mind. At the same time it should be understood that the treatment of these conditions does not differ from that employed when measles does not enter into their causation. While it is not intended to enter into the treatment of extraneous diseases with any degree of completeness, a few suggestions at this time may not be out of place.

Some writers lay great stress on the retarded or light appearance of the exanthem. This is especially so among the older writers. Among recent writers Larrabee[562] believes that the treatment should be directed to facilitate the prompt development of the cutaneous eruption. For this purpose he advises the administration of the iodides with diaphoretics or the sheet pack wrung out of hot water to which mustard has been added. Paulet[563] regards cocaine (0.3 grain, or 0.02

[561] Hutinel: La Méd. Mod., Jan. 26, 1895.
[562] Larrabee: Pediatrics, Oct. 1, 1897.
[563] Paulet: New York Med. Jour., June 5, 1897.

gramme, daily to a child five years old) a sovereign remedy in bringing out a tardy eruption. Unless there exists some special reason for causing a prompt determination of blood to the surface, mild measures—such as warm baths and moderate bed-covering—are to be preferred to more radical means, for, in the author's experience, no unfavorable prognostic significance can be attached either to the tardy appearance or mild character of the eruption.

The Skin and Mucous Membranes.—When the mild antiseptics previously mentioned prove inefficient, all purulent accumulations must be freely opened and cavities or secreting surfaces flushed with a 1-to-1000 solution of corrosive sublimate. To the eye, half the strength may be applied once or twice daily as indicated. Should ulcerative stomatitis supervene, a pledget of cotton saturated with a 1-to-500 solution of the same drug may be applied two or three times a day. It must be used, however, with the greatest care, and only by the physician. Safer, especially in young children, is a 10-per-cent. solution of the silver nitrate. In most cases the early and frequent application of these will prevent more radical measures, such as chromic acid, the actual cautery, and other escharotics. The importance of rendering all lesions as aseptic as possible cannot be too strongly insisted upon.

Laryngitis.—The prompt application of cold to the throat, when the larynx first shows signs of inflammation, will sometimes avert more serious trouble. It should not be continued long unless followed by marked benefit. When farther advanced, hot applications, with the object of producing a strong, revulsive action, should be made. To accomplish this a cloth or napkin folded and wrung out of water as hot as can be borne is placed just above the sternum. It must be changed as soon as the temperature lowers, and reapplied. It is not advisable to burn or cause blisters to form; hence the second application must be at a lower temperature. In all cases a mustard foot-bath should be given at the onset. In the less severe forms, and when breathing is not seriously interfered with, these, with the inhalation of steam and the frequent use of the spray previously mentioned, usually suffice. When the laryngitis becomes severe and a whitish membrane appears, or with the supervention of dyspnœa, the physician must bear in mind the possible necessity of intubation or tracheotomy. The bowels should be freely opened by castor-oil or small, frequently repeated doses of calomel. In robust, full-blooded subjects, especially when accompanied by congestion of the face, one or two leeches applied to the neck above the sternum is highly spoken of by Williams.

Of all measures, the steam inhalations are the most important. The apparatus can readily be extemporized; a tent made by throwing a sheet over the head of the bed and fastened at the sides will suffice. The nozzle of the tea-kettle filled with boiling water is then introduced under the sheet, which soon fills the tent with vapor. Creasote or turpentine may be added to the water, or lime-water may be used. The length of time the inhalation should continue varies with the severity of the case: when mild, from fifteen to twenty minutes every two or three hours, while in severe cases it may be used almost continuously. In the suffocative form an effort should be made to cause a rapid determination of the blood to the surface, which may be induced by the mustard pack, brisk rubbing, or dry cupping, followed by hot fomentations. These failing, oxygen should be given.

Diphtheria.—Although sometimes appearing as a complication of measles, diphtheria does not call for special consideration, as it requires the same treatment that it would under other conditions.

Broncho-pneumonia.—Capillary bronchitis is the most to be dreaded of all the complications of measles. On this account the medical attendant should ever be on the alert to detect the early symptoms of the disease. The principles involved in its treatment embrace the following: To supply the lungs with oxygen, to support the heart's action, and to maintain the temperature as nearly normal as possible. To insure the first, the room should be freely supplied with fresh air, and the patient's head and shoulders must be elevated upon pillows. He should not be allowed to remain constantly in one position, and an effort should be made to free the lungs from accumulated mucus. In all cases the bowels must receive attention, and if constipated, enemata or castor-oil should be given. It is important that the peripheral circulation be encouraged; this may be done by the mustard foot-bath and the mustard jacket to the chest. The former may be made by adding 2 tablespoonfuls of mustard to 3 gallons of hot water, and the jacket by mixing 1 part mustard to 6 parts of wheat flour, with sufficient water to make a paste. This is spread between two layers of cloth and applied to the chest until the skin becomes reddened. Holt (*loc. cit.*) speaks highly of the oiled silk jacket, which should be worn constantly. It is to be preferred to constant poulticing, and is even more efficient, besides being more cleanly and easy of application. An effort should likewise be made to encourage deep inspiration. With a deficient aëration of the blood, and its effect on the respiratory centre, there is less inclination to inspire freely, and in extreme cases, unless

energetic measures are taken, death soon follows. In this condition von Jürgensen (*loc. cit.*, p. 163) recommends the use of alternating hot and cold douches to the chest, and if there be much accumulation of mucus in the larger tubes, as evidenced by the appearance of coarse râles widely distributed in addition to the fine crepitations, an emetic may be given.

The following procedure is also highly spoken of by Thomas[564]: A folded sheet wrung out of cold water is placed under the patient, the bed being protected by means of a rubber sheet or folded blanket placed underneath. The patient is quickly wrapped in the cold sheet, which causes deep inspiratory movements and expectoration of frothy mucus. In addition to the violent respiratory movements which it causes, it serves to reduce the temperature and stimulates the heart's action. The process may therefore be renewed every half-hour until the temperature decreases and the pulse and respirations become less frequent. The skin is then dried and clean clothing put on, after which the patient should be moderately covered, when a degree of quiet or even refreshing sleep frequently follows. This should be repeated when the temperature again becomes high and the dyspnœa returns. Of the emetics, apomorphine and the wine of ipecacuanha answer best. They should not be given when the pulse is feeble and there is marked prostration or stupor. Stimulants, such as strychnine (to a child one year old $^1/_{300}$ grain, 0.000216 gramme, every three hours), given hypodermically, whisky, brandy, sherry wine, are now indicated, and the diet should be as nutritious as possible. It is sometimes advisable to give nutritive enemata. According to Holt, stimulants are most needed when the temperature is low or falls suddenly, as sometimes occurs at the crisis of the disease, and should be given when the pulse is weak, compressible, rapid, and irregular. The quantity given naturally should be regulated by the age of the patient and urgency of the case, from $^1/_2$ to 2 ounces (15 to 60 centimetres) of whisky or brandy, diluted with 8 volumes of water, may be given daily to a child one year old. As pointed out by this author, children may be more easily induced to take some of the sweet wines, such as sherry or Tokay. Lomikovsky[565] recommends, in the treatment of lobar pneumonia associated with measles, large doses of digitalis. He has not observed any depressing effect on the heart following its use.

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[564] Thomas (*loc. cit.*, p. 124).

[565] Lomikovsky: La Méd. Mod., Feb. 27, 1895.

When heart-failure seems imminent, trinitrin (nitroglycerin), in young children $^1/_{500}$ grain (0.00013 gramme) every hour until four or five doses have been given, or oxygen holds out the greatest hope. When broncho-pneumonia appears in a general ward or when there are other cases of measles, it should be isolated, and the room fumigated, as it is known to be communicated from one to another. At the Hôspice des Enfants Assistés, Paris, when cases of broncho-pneumonia break out in the measles ward, they are promptly segregated by means of glass boxes, about three metres in height, and sufficiently large to admit two beds. These boxes are kept open at the top and are placed against the wall inclosing an outside window, thus securing free ventilation. Its construction of glass renders it less lonesome for a child. It is claimed that no instances of outside infection have occurred since its use.

The Nervous System.—The early disturbances of the nerve-centres, such as convulsions, when not frequent nor protracted, occurring at the onset of the disease, call for no special treatment. When they occur during the acme of the efflorescence accompanied by high fever, cold applications should be applied to the scalp and nape of the neck. Guinon[566] recommends cold baths, the water being gradually cooled, and the pouring of cold water on the head. Thomas (*loc. cit.*) recommends stimulants (wine, benzoic acid, or camphor) in large doses, and if the surface is cold the employment of warm baths and cool douches upon the head. When there is apathy and marked congestion of the face, in addition to the ice-bag, leeches may be applied to the mastoid. This is advisable in very young children only when they are robust, while in older children or adults free bleeding is sometimes followed by the disappearance of these ominous symptoms. Internally, Williams speaks well of antipyrin given in one full dose, appropriate to the age and condition of the patient, preferably in the afternoon. When there are signs of adynamia with high fever, quinine sulphate is indicated (1 to 2 grains—0.065 to 0.2 gramme) for every year of age, three times daily. If diarrhœa be present the tannate of quinine in double the dose is to be preferred.

Otitis.—The frequency of inflammation of the middle ear and its serious consequences necessitates special attention to these organs in all cases of measles. Moreover, much can be done to obviate total or even partial loss of hearing, if accumulations of mucus in the naso-

[566] Guinon: Blätter f. klin. Hydrotherapie, July, 1891.

pharynx and Eustachian tubes are encouraged to escape. For this purpose frequent gargling with antiseptics and cleansing the nares by means of the spray should be employed. In infants the careful use of a swab, made by rolling sterilized cotton about a tooth-pick or probe, dipped in peroxide of hydrogen, the boric-acid solution previously given, or other bland antiseptic should not be neglected. In cool weather care should be taken that the fluid is rendered lukewarm. After cleansing the mucous surfaces within reach, Williams recommends the application of an ointment composed of 5 minims of oil of eucalyptus to an ounce of vaselin. This may be applied with a camel's-hair pencil. Sometimes in older children accumulations may be prevented by directing the frequent blowing of the nose, or by the use of Politzer's inflation-bag. This latter should, however, not be used oftener than once a day, and then only by the physician. It should be discontinued if the ear becomes painful. To relieve the pain, hot applications are often effectual, or the introduction of cocaine or atropine or the two combined, of each, 2 to 3 per cent. in water. A few drops may be instilled into the canal by placing the opposite side of the head on a pillow and allowing the fluid to percolate about the drum. As soon as there are evidences of pus accumulation, or bulging of the tympanum, the membrane must be incised without delay. This is accomplished by the head being firmly held by an assistant, allowing the light reflected from a head-mirror to strike the drum, when an opening is made in the lower and posterior segment of the membrane. The canal should then be flushed with equal parts of warm water and peroxide of hydrogen, repeated two or three times a day. The ear-drum should be inspected at frequent intervals, lest it close up, when the operation must be repeated. At other times the membrane ruptures of its own accord, in which case an impairment of hearing is liable to follow. When the services of an aurist are available it is always advisable to intrust this complication to his immediate care. When the septic process invades the mastoid cells, the services of the surgeon should immediately be secured.

In *pregnancy*, should a miscarriage occur, the greatest precautions must be taken to guard against septicæmia.

Finally, convalescence in measles is often protracted, and the patient must guard against undue exposure to inclement weather, overfatigue, eye-strain, or too close application to study. It is sometimes necessary to send city children into the country, and, if signs of tuberculosis appear, change of climate may be advisable.

CHAPTER VII.

RUBELLA.[567]

(German measles,[568] false measles, *rubeola sine catarrho*, *rubeola notha*, hybrid measles, *scarlatina morbillosa*, *morbilli scarlatinosa*, bastard measles, bastard scarlatina, epidemic roseola; French, *rubéole*; German, *rötheln*,[569] *rubeola*.)

DEFINITION.

A MILD, epidemic, contagious, and, to a very slight extent, infective, eruptive disorder of short duration, characterized by the appearance of a faded pink or faint-reddish, fine macular eruption, accompanied by enlargement of the superficial lymphatic glands of the neck, and disappearing in three or four days. It is usually preceded or accompanied by a slight congestion of the fauces, tonsils, and conjunctivæ, and, while presenting in a minor degree some of the characteristic features of both measles and scarlatina, is in no way related to either. Like the other exanthemata, it is self-protective, and immunity is conferred by one attack.

Unlike the other exanthemata, rubella seems to have escaped the observation of the ancients, unless the Arabian, *Hhamikah* or *Humak*, employed by Avicenna, refers to it as some believe (see page 13). The succeeding ages of medical chaos not only failed to bring forth any new development in the class of affections now under consideration, but well-nigh succeeded in obliterating the line of demarkation between the clearly defined diseases of the exanthem group, which had already been established. It is not strange, therefore, that an evanescent affection having no striking features, and even these at times counterfeited by both measles and scarlatina, should fail of recognition until the beginning of what might be termed, despite a few brilliant individual exceptions, the *renaissance* of medicine, about the middle of the eighteenth century.

The disease we now call rubella, the Germans *rötheln*, and the French *rubéole*, first attracted attention, according to Thomas, in

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[567] Diminutive of rubeola, from *ruber*, red. The English equivalent of the German *rötheln*, and first used by Veale, of England, in 1866, and which has met with general acceptance by English writers.

[568] Because thought to have been first described by German authors.

[569] Diminutive of *roth*, red (see page 25).

France and England, where it was called "roseola," although the first clear description of the disease, according to Griffith,[570] was given by De Bergen, of Germany (1752), who maintained that it should be differentiated from both measles and scarlatina.[571] Unfortunately he employed the term roseola (*de roseolis*), which later lost its specific significance and became one of the twelve varieties described by Willan. Orlow[572] (1758), likewise, while he did not decidedly advocate its acceptation as a disease *sui generis*, presented a clinical picture which demonstrates his familiarity with the affection as we know it to-day. Then came the difficulties of diagnosis resulting from the absence of striking as well as constant clinical features, and epidemics were reported exceeding in virulence that observed in either measles or scarlatina. Thus, Formey[573] states that between 1784 and 1796 there died from rötheln in Berlin alone 1180 persons, while only 205 deaths occurred from scarlatina and 103 from measles. He speaks of the early formation of a whitish membrane in the throat, with subsequent severe nervous symptoms, such as coma and delirium. Naturally such apparent errors of diagnosis led to great confusion and the rejection of rubella as a specific disease on the part of the majority of German physicians.

In England Sydenham (1685) included it with scarlet fever, as did Morton (1694), who, according to Squire, spoke of scarlatina as a mild form of scarlet fever, which latter affection he referred to as "confluent measles." Willan (1808) and Bateman (1814) described a *rubeola sine catarrho*, which, they observed, did not protect from measles, while it remained for Maton[574] (1815) to establish the fact, based on observation, that, while it is self-protective, it does not confer immunity to either measles or scarlatina, nor do these diseases protect against rubella. From this time forth various opinions were held. Many—from Henke[575] in 1818, Wunderlich[576] in 1856, to Köstlein[577] as late as 1865—maintained that it was a modified or anomalous form of measles; others—among whom may be mentioned, Reil[578] (1790),

[570] Griffith (J. P. Crozer): New York Med. Record, July 2 and 9, 1887.

[571] The author has been unable to verify the claim of De Bergen's priority of unequivocal description.

[572] Orlow: "De rub. et morbill. discrim.," Progr. Königsb., 1758 (Thomas).

[573] Formey, quoted by Griffith and von Jürgensen (*loc. cit.*, p. 263).

[574] Maton: "Med. Trans. of the Royal Coll. of Physicians" (London, 1815), vol. v, p. 149.

[575] Henke: "Hdb. d. Kndrkkh.," 1818 (Thomas).

[576] Wunderlich: "Path.," 2 Aufl., 1856 (Thomas).

[577] Köstlein: Wiener. med. Presse, 1868, 13.

[578] Reil: *Ibid.*

Hufeland[579] (1793), Heim[580] (1812), and Göden[581] (1822)—considered it a form of scarlatina; while Hildebrand[582] (1825), Schönlein[583] (1832), Canstatt[584] (1847), Gintrac[585] (1858), Hebra (1865), and Aitkin (1870) looked upon it as an intermediate or hybrid form of measles or scarlatina, and still others, with Jahn[586] (1835), denied its existence entirely.

From the utter lack of uniformity of opinion as well as in nomenclature, as the long list of synonyms attests, little or no progress was made in assigning rubella its proper place until within the memory of those still living. In fact, until within the last two decades of the nineteenth century authors were still at variance concerning what seemed to be a perplexing nosological problem. Further, with the influence of such celebrated teachers as Hebra, Niemeyer, Henoch, and Fagge to contend against, it was no easy task to offer proof sufficiently convincing for general acceptance, nor to place the specificity of rubella on a firm basis. Added to this the mild nature of the disease and the fact that few patients entered hospitals or even applied for medical aid, and the comparative infrequency of epidemics, the outlook of arriving at any uniformity of opinion seemed well-nigh hopeless. To the careful observations and writings of Homans[587] (1845), Cotting[588] (1853), Howard[589] (1871), J. Lewis Smith, Hatfield, Park, Earle, Edwards, Atkinson, Griffith, and Hardaway, in America; Alibert, Trousseau, and Sévestre, in France; and, in Germany, Thierfelder, Wunderlich, Oesterreich, von Ziemssen, Laube, and Thomas, we are indebted for solving the nosological problem of rubella and its many pseudonyms, and demonstrating beyond reasonable doubt the specific nature of the disease. In this view the author believes the consensus of opinion in all countries is now in accord.

From a clinical study covering a period of twenty years the present writer has observed that the requirements which entitle rubella to be classed as a distinct affection are sufficiently uniform to warrant the following deductions:—

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[579] Hufeland: *Ibid.*

[580] Heim: Horn's Archiv (1809), B. 7, and Hufeland's Jour., 1812, iii, 61.

[581] Göden, cited by Griffith. [582] Hildebrand (*vide* Thomas, *loc. cit.*).

[583] Schönlein: *Ibid.* [584] Canstatt: "Handbuch," ii, 1847 (Thomas).

[585] Gintrac: "Canst. Jahresb.," 1858, and Jour. de Bord., 1862 (Thomas).

[586] Jahn: Anal. üb. Kinderheilk., 4, p. 150.

[587] Cited by J. Lewis Smith: "Med. and Surg. Dis. of Infancy and Childhood" (Philadelphia, 1896).

[588] Cotting: Boston Med. and Surg. Jour., March 15, 1873.

[589] Howard: *Ibid.*

First. Rubella is a mild form of infection which always follows a benignant course and first appears as a general or constitutional disease, accompanied by a slight rise of temperature and slight feeling of illness. In this it conforms to the other affections of this class.

Second. The local manifestations, while partaking of the character of those observed in both scarlet fever and measles, are distinct, and possess an individuality which, as a rule, may be recognized by the trained eye.

Third. While we have no exact knowledge of the cause of the disease and in what respect the virus differs from that of other diseases to which it bears the closest resemblance, yet we do know that it is contagious, and always gives rise to a like disease: in short, conforms to the type.

Fourth. It occurs but once in the same individual, from which we infer that it is self-protective, while it affords no protection to, or modification of, measles or scarlatina; nor has it appeared that they offer any protection against rubella. It must be remembered, moreover, that even mild forms of the various exanthemata are self-protective. The fact that the patient at some previous time has had either scarlet fever or measles, or both of these affections in a well marked degree, often leads to its recognition. Sometimes, even before its true nature has been definitely settled in the mind of the medical attendant, the disease disappears.

Fifth. Like the other exanthemata, it always appears in the form of an epidemic, which seems to bear little or no relation to epidemics of other diseases, such as scarlet fever or measles. It sometimes occurs independently; again, two or more of the epidemic exanthemata prevail at the same time. It must be admitted that extraneous conditions of weather and possibly of sanitation predispose in a like degree to all. Though epidemics of rubella seem to occur at less frequent intervals than do those of either scarlatina or measles, there can be no doubt that very many epidemics of rubella escape recognition, and are regarded as mild or aberrant forms of one or the other of the first-named affections. While the author believes, with Atkinson,[590] that unless more exact methods are adopted in the study of the exanthemata there is still danger of endless confusion, and that the

[590] The study of *röthein* is thus rapidly becoming obscured by fantastic and motley embellishments, and there is reason to fear that the resulting confusion will reawaken the early skepticism concerning it. Atkinson (*loc. cit.*, p. 19). Amer. Jour. Med. Sciences, Jan., 1887.

practice of relegating all mild or otherwise anomalous forms of measles or scarlatina to rubella is, as it was thirteen years ago, far too prevalent; yet the remedy lies in giving to this important group of affections a more conspicuous position than it now holds in the curriculum of clinical instruction. This will be further considered under diagnosis.

SYMPTOMATOLOGY.

As in the other exanthemata, the symptoms of rubella may be grouped into three stages, although, on account of its mild nature, these are even less clearly defined than is observed in the other diseases of this class, and what may be termed the type or cardinal clinical symptoms are subject to great variability. To this must be attributed the difficulty experienced in the diagnosis, and the hesitancy on the part of some in ascribing to the affection a distinctive position.

Period of Incubation.—From fifteen to eighteen days usually elapse after the reception of the specific virus before the first symptoms appear. Greater variability is shown than occurs in measles, although it is generally conceded to be somewhat longer than in measles. In an epidemic of fifty cases Griffith (*loc. cit.*) found the period of incubation to vary from 5 in one case to 11 days in twenty-eight cases, and Robinson[591] regards the latent stage as varying from 6 to 7 days. Bristowe[592] likewise gives 1 week as the usual time. The difficulty of obtaining accurate data concerning the latent stage of rubella is ably pointed out by Thomas, who believes in a definite period varying only within narrow limits, and offers in confirmation that members of the same family, after a presumably simultaneous infection, usually fall ill at exactly the same time. Conversely, Griffith considers the varying period of incubation characteristic of the disease, and therefore of diagnostic value. Since it is impossible to determine in many cases the exact time of infection, the short duration given must be looked upon as at least marked exceptions to the rule. On the other hand, while most authors give from 2 to 3 weeks as the usual period, Klaatsch[593] has recorded cases in which even 4 weeks were supposed to have elapsed before the first symptoms of the disease occurred. During this period no evidence of infection is present.

Period of Invasion.—Unlike measles, this stage is ill defined,

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[591] Robinson: Med. Times and Gazette (London, 1880).
[592] Bristowe: "Practice of Medicine" (London, 1880).
[593] Klaatsch: Zeit. f. klin. Med., 1885, 10, 1, and cited by von Jürgensen, p. 166.

and in many cases the symptoms are entirely overlooked, although, when the eruption appears, it is often recalled that during the preceding day a slight feeling of illness, with headache, was experienced. This is especially the case in adults. At other times the prodromal symptoms are observed only a few hours before the appearance of the exanthem, and some (Whittaker, Hardaway) believe that in the majority of cases they are wholly absent. In children, according to the writer's observation, there are usually some mild catarrhal symptoms which sometimes resemble, although to a lesser degree, those observed in measles, while their duration is at most not longer than twenty-four hours instead of four days as in the latter disease. A suffusion of the conjunctivæ is nearly always present, although there is less photophobia than in measles. The throat is usually affected simultaneously, and pain on deglutition is sometimes complained of.

At this time the tonsils may be found swollen and the fauces injected. In some cases hoarseness and cough are present. No enanthem has been observed at this time, although the buccal mucosa sometimes presents a pinkish tint a few hours before the cutaneous exanthem appears. In delicate, neurasthenic children the symptoms may be even more pronounced, consisting of restlessness, some anorexia, and rarely nausea and vomiting. There may be shivering, giddiness, and aching of the extremities. In one hundred and nineteen cases von Nymann noted rigors in nineteen. J. Lewis Smith[594] observed convulsions, and Hardaway[595] has reported a case in which this stage began with mild delirium. Both, however, must be looked upon as anomalous, indicating an abnormal sensibility on the part of the patient. There is usually, toward the end of this stage, from two to twelve hours before the eruption, a slight rise of temperature, which gradually increases to 100° or 101° F. (38.4° C.), rarely higher. This may be of short duration or remain until the acme of the disease is reached. In general, the presence or absence of fever during the initial stage depends on, or at least is proportionate to, the concomitant symptoms, and, while the observation of the present writer is not wholly in accord with Atkinson[596] and Duckworth,[597] that the short duration or entire absence of febrile symptoms previous to the appearance of the eruption is

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[594] Smith (J. Lewis), *loc. cit.*

[595] Hardaway (W. A.): "Rötheln," in Pepper's "System of Med." (Philadelphia, 1885), vol. i.

[596] Atkinson (*loc. cit.*).

[597] Duckworth: London Lancet, 1880, vol. i, 395.

buccal and pharyngeal cavities present the most noteworthy symptoms. Thus, catarrh of the former, while less intense than in measles, is seldom wholly absent, so that coughing and sneezing are among the most constant symptoms at the beginning of the disease. His observations concerning the mucous membranes of the mouth and throat confirm what has previously been said.

While the congestion seems to be exaggerated about various foci, it is by no means limited to well defined spots, nor does it conform to the typical picture of the cutaneous exanthem. More frequently the only symptoms referable to the mucous surfaces are at first a uniform erythema of the soft palate, and to a less extent the pharynx, and sometimes congestion and moderate swelling of the tonsils. As the cutaneous eruption develops, the mottling of the mucous surface becomes more apparent and sometimes the color is intensified in certain small areas, which lend an appearance quite suggestive of the cutaneous efflorescence, although never forming the well defined lesions nor the intervening background approximating the normal color, as in the latter.

Of more importance from a diagnostic point of view, and withal one of the most constant symptoms of rubella, is the enlargement of the superficial lymphatic glands. (See Plate XLI.) This may usually be detected at an early stage, and, as Thierfelder[605] remarks, swelling of the subauricular and superior jugular lymphatic glands may be looked upon as a constant prodromal symptom. According to Atkinson,[606] enlargement of the superficial lymphatic glands of the neck may be the most striking symptom, and sometimes attracts attention several days before the beginning of the eruption, while Emminghaus[607] says it is very frequently present to a slight extent and may subside even before the eruption appears. My own notes of cases show adenopathy in 96 per cent., of which the maxillary and superficial or post-cervical were the most frequently involved; next the occipital, posterior and anterior auricular; and sometimes the superficial inguinal, axillary, and the epitrochlear. In the neck the inflammation may be sufficiently severe to interfere with free movement, and in two or three instances it has given rise to marked œdema of the surrounding parts. In no instance has suppuration taken place. The involvement of the various

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[605] Thierfelder: Greifsw. Med. Beitr., B. 2, Ber., p. 14, 1864.

[606] Atkinson (*loc. cit.*, p. 23).

[607] Emminghaus: In Gerhardt's "Handbuch," p. 351. Also quoted by Atkinson and von Jürgensen.

PLATE XLI.

XLI

RUBELLA—showing a typical eruption with enlargement of the post-cervical lymphatic glands.

groups of lymphatic ganglia is coincident with the regional disturbance in the skin and mucous membranes.

From the literature of this subject it may be seen that there is a unanimity of opinion concerning the glandular enlargement which is quite unusual in regard to the other symptoms of this disease. Eustace Smith,[608] however, states that it is only seen in some epidemics, and Kassowitz[609] observed adenopathy only in one-third of his cases. The spleen remains unaffected.

The Skin.—By far the most striking, as well as the most constant feature of the disease is the eruption on the skin. This, in the majority of cases, constitutes the only symptom that attracts attention, and without which the affection would be unrecognizable. Like variola and measles, the eruption in rubella first appears on the face and scalp, and some—with Emminghaus, Edwards, and Cuomo[610]—have observed a slight, more or less uniform efflorescence immediately preceding the true eruption. This I have never encountered, and believe it should be looked upon as a very rare exception. The eruption makes its appearance in the form of faint pinkish maculæ, at first discrete, but sometimes becoming more or less confluent within a few hours. Next, the neck and upper part of the trunk become involved, after which the eruption spreads out over the whole trunk and the upper and lower extremities in the order named. The palms and soles partake, though to a less extent, in the general efflorescence. From one to two days are usually occupied in completing the process of extension. The eruption attains its full development within from ten to fourteen hours on any particular part, so that the maxima in various regions do not occur at the same time. Thus, the eruption has already begun to fade on the face before it is fully developed on the trunk, and it usually has well-nigh disappeared on the face before the legs are involved. Unless the case is seen at a very early stage, the face may appear to have escaped. Hardaway very properly lays great stress on this feature as a valuable means of distinguishing rubella from measles. When the maximum development is reached the individual lesions are sometimes perceptibly elevated, and in size vary from a pin-head or lentil to a small bean. They are often slightly elongated or irregularly round in shape, with an ill-defined border, and disappear completely on pressure.

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[608] Smith (Eustace): "Diseases of Children" (New York, 1884), p. 31.
[609] Kassowitz: "Transactions Internat. Med. Cong." (London, 1881), vid. iv, p. 10.
[610] Cuomo: Gior. internaz. d. sci. med. (Napoli, 1884), vi, p. 529.

Unlike measles, they show no tendency to form groups, clusters, or crescents, and in some cases manifest a feebler predilection to coalesce. Sometimes, however, when confluent, they extend at the periphery, coalesce, and form extensive areas, when the resemblance to scarlatina may lead to an error in diagnosis.

Usually the *plaques* thus formed are found only on certain parts, while on the remaining portions of the body the eruption presents the more usual appearance. The color is always lighter than that observed in scarlet fever, and in a strong light the slight elevations which correspond to the original lesions may be discerned. Further, the eruption is fairly uniform in color and may be described as of a faded rose or pink tint, never, in my experience, presenting the fiery red of scarlatina nor the dusky, bluish red of measles. Ordinarily the eruption bears the closest resemblance to measles, but when the lesions are small and confluent, as sometimes happens, its resemblance to scarlatina may be quite striking. Again, the rash may be morbilliform; that is, large and discrete on some parts, and confluent, or scarlatiniform, on others. These variations, which the writer has many times observed, sometimes give rise to much uncertainty in diagnosis, and undoubtedly have retarded the general recognition of the disease. It must be borne in mind that the eruption is not always uniform, and different cases, as well as different epidemics, vary considerably. There are, in addition, atypical and anomalous forms, in which a correct diagnosis would scarcely be arrived at were it not for other cases in the neighborhood which conform more closely to the usual type.

In the development of the exanthem many changes may be noted in the appearance of the rash. Thus, at first the spots offer a feeble contrast to the intervening unaffected skin; soon, however, they acquire a brighter color and more definite form. Each spot is surrounded by an areola which renders the centre darker, while the margin is less clearly defined. The eruption is most abundant on the face, chest, back, and nates, and in some cases has seemed to be aggravated by local irritation, as from bands of clothing, garters, and warmth. In this respect it resembles variola. Hæmorrhages into the lesions have been observed (Dunlap), but they are exceedingly rare. Œdema of the face occurring coincidently with the eruption is recorded by Douglas and Griffith.

The objective symptoms are, therefore, a *mélange* representing both those of measles and scarlatina, with a preponderance at times of one or the other, yet always adhering to the type formed by the blend-

PLATE XLII.

PLATE XLII.

Rubella, showing Well-Marked Eruption at its Height on the Back.

ing of the two. This in no sense is to be construed as relating to the etiology of the disease nor as militating against its independent nature.

Subjective symptoms are almost entirely absent in a great many cases. When present they are of a mild nature, and it is with difficulty that patients are retained within doors during the whole course of the disease. With the full development of the exanthem the mucous membranes begin to assume their normal appearance; sometimes the throat remains congested and the catarrh of the upper air-passages remains for a week or more; but this is the exception, and usually the normal condition is reached before the disappearance of the exanthem.

The Temperature.—It is to be expected that much difference of opinion should prevail concerning the presence or absence of fever in rubella, as so many extraneous influences, such as digestive disturbances and inflammation of the mucous and serous membranes, are liable to modify the temperature and thus render it unduly high. Different epidemics also seem to vary in this particular; moreover, still greater influence must be attributed to the previous health and sanitary surroundings of the patient. Again, in conformity with the class of eruptive fevers, a slight rise of temperature must be looked upon as characteristic of the disease. As with the early efflorescence of syphilis, so here, a slight rise of temperature is invariably present. The experience of most authors is sufficiently conclusive in this particular, but statements vary as to the time and degree of fever present. According to Emminghaus, when the initial fever is not detected, the temperature curve may not be noticeable until the acme is reached, or the crisis, followed by an oscillation just above or even below the normal, terminates the fever. When the fever continues throughout the course of the disease, it shows a remittent character and terminates, either by crisis or lysis, within from two to four days. The highest point of the curve never coincides with the maximum of the eruption on any part of the body. Thus, the temperature curve has not reached the highest point when the region first attacked has reached its maximum, while the curve, with slight exacerbations, has already returned to the normal line before the eruption on the part of the body last to be affected has attained its maximum development. Should the temperature again rise above the initial curve, a relapse or some complication may be expected. The cases recorded by Edwards (*loc. cit.*, p. 694) presented a rise of temperature during the eruptive stage ranging from 1 to 3 degrees, and sometimes showing even 103° or 104° F. (39.4° to 40° C.), which, as a rule, corresponded to the severity of the eruption.

Further, the temperature curve was very variable, sudden elevations with equally sudden falls being not infrequent, and in some cases only a fraction above the normal was recorded throughout the entire course. On the other hand, Thomas observed no fever during the whole course of the disease in a majority of his cases, while in some there was an initial rise of temperature which either disappeared on the second day of the eruption or continued until the third day, when it usually ended abruptly by crisis. Of 119 cases von Nymann[611] failed to detect any appreciable rise of temperature in 58, and in the remaining 61 cases the temperature ranged as follows:—

In	39	cases	the	highest	recorded	was 100.4° F. (38.0° C.).
"	14	"	"	"	"	" 101.3° F. (38.5° C.).
"	6	"	"	"	"	" 102.2° F. (39.0° C.).
"	2	"	"	"	"	" 103.1° F. (39.5° C.).

Von Jürgensen (*loc. cit.*, p. 269) says that very often during the whole course of the disease no rise of temperature can be detected, and that when present it is of short duration and never, unless due to complications, remains longer than four days. This view, according to Griffith, is held by Wunderlich, Vogel, Earl, and Picot.

It must be conceded from the foregoing that the temperature is subject to great variations, and while fever is present in most cases it cannot be considered as in any way characteristic of the disease. It seldom rises above 100° or 102° F. (37.7° to 38.8° C.), which may be considered the rule, and it returns to the normal even before the complete disappearance of the eruption.

The pulse and respiration are not perceptibly affected in rubella, and correspond, for the most part, to the temperature curve. Liveing records a pulse-rate of 144 with a temperature of 100.3° F. In two of Griffith's cases, with moderate fever, the pulse-rate was 150.

The Urine.—As a rule, no changes in the urinary secretion, aside from those usually observed in slight febrile conditions, are present. Although slight albuminuria has been recorded by Liveing, Edwards, Hatfield, and others, it must be admitted to be of uncommon occurrence, and seldom of serious import.

THE PERIOD OF DESQUAMATION is more or less coincident with that of the eruption. After attaining full maturity the individual lesions rapidly fade, leaving a faint fawn color or yellowish, macular or "marbled" appearance of the skin. This, it may be noted, is not

[611] Von Nymann, quoted by von Jürgensen.

always present, and usually is not sufficiently marked to attract attention unless especially looked for. As previously described, this goes on in successive periods over different parts of the body from above downward, so that the process is entirely completed on parts first attacked, before desquamation has well set in on the regions last invaded. Properly speaking, therefore, there is no stage of desquamation that can be applied to the disease as a whole, but only to its regional development. This begins from six to twelve hours after the efflorescence appears. The time occupied in the whole eruptive and desquamative processes varies from two to four days. This is subject to great variation, however, as shown in von Nymann's 119 cases as follows: From the outbreak to the complete disappearance of the eruption it was

1 day	in 10 cases	(8.40	per	cent.).
2 days	" 29 "	(24.36	"	").
3 "	" 31 "	(26.65	"	").
4 "	" 33 "	(27.73	"	").
5 "	" 12 "	(10.08	"	").
6 "	" 3 "	(2.52	"	").
7 "	" 1 case	(0.55	"	").

Abnormally long periods have been reported by Liveing—eight to ten days (Atkinson), and Edwards—fifteen days. They are rare anomalies. In 100 cases the writer last quoted found the eruptive processes were completed in an average of five days. This is a longer average than in the cases which have come under the author's observation.

As a rule, there is much less desquamation than is observed in scarlatina, and in most cases it is almost imperceptible. On the palms and soles the flakes are larger and therefore more noticeable than on other parts of the body, where exfoliation takes place in the form of branny or furfuraceous scales. It is usually most abundant on the face and neck, and is especially noticeable about the nose. Itching is sometimes troublesome.

COMPLICATIONS AND SEQUELÆ.

In a large majority of cases rubella is neither accompanied by complications nor followed by sequelæ, and with normal health preceding, and surroundings conducive to the same, it may be considered free from the dangers incident to both scarlet fever and measles. On the other hand, it is to be remembered that even trivial deviations from the normal sometimes incite or even give rise to various diseases which

may have lain dormant or to which a strong predisposition exists. Therefore it is not surprising that a mild affection like rubella should in some instances act as an exciting factor to the long list of diseases which have been from time to time ascribed to it. In asylums, homes for children, and in thickly settled tenement-house districts of cities the greatest danger naturally exists. Edwards (*loc. cit.*, p. 697) mentions pneumonia as occurring three times in a series of one hundred cases, while Griffith reports it twice in one hundred and fifty cases. The former likewise reports several cases of severe bronchitis and one of pleurisy. Other observers have likewise encountered bronchitis and pneumonia. Next to the respiratory, the digestive tract seems to be most affected, and Edwards has recorded about 40 per cent. of cases having some form of gastro-intestinal irritation. This, the author quoted admits, is out of the common, and ascribes it to the bad hygienic surroundings and the severity of the epidemic. Abscess of the submaxillary lymphatic glands is reported by Golson[612]; naso-pharyngeal catarrh and permanent swelling of the tonsils by Mettenheimer[613]; and ciliary blepharitis and otorrhœa by Hardaway.[614] Most of these instances are generally conceded to be quite unique in the history of the disease. They indicate, however, the catarrhal character of the complications most liable to arise, and in strumous children, with a pre-existing naso-pharyngeal catarrh, serious impairment of hearing might readily follow.

Relapse.—In this respect rubella does not differ from the other exanthemata. Edwards observed a relapse on the fourth day and another on the twentieth day after the initial eruption. Griffith noted a relapse in three instances, one occurring on the eleventh day, and the others after an interval of nearly three weeks. Other cases are on record, most of which took place within a fortnight or three weeks after the primary attack. The second attack does not seem to differ in any particular, excepting that the prodromal symptoms are wholly absent. A second attack—that is, a reinfection—of rubella, according to Hardaway, has never been reported.

PATHOLOGY.

On account of the mild and evanescent character of rubella little attention has been given to its pathology. Thomas enters at length

[612] Golson: "Transac. Med. Assoc. Alabama," 1883.
[613] Mettenheimer: Jour. f. Kinderk., 1869, liii.
[614] Hardaway (*loc. cit.*).

into the usual changes observed in the skin, but, aside from the statement that the efflorescence is due to capillary hyperæmia of the papillary bodies and uppermost layers of the derma, giving rise in some instances to slight exudation, does not enter into any further histological findings. Both Formad and Edwards describe micrococci in the blood in some cases of rubella, but, as similar bodies have been observed by Keating[615] and others in measles, their etiological rôle is uncertain. Therefore it must be admitted with our present knowledge that little or nothing is known as to the histological changes of rubella, nor of the active principle which gives rise to the disease.

ETIOLOGY.

Our knowledge of the development of rubella as a distinct disease must still be looked upon as being in a rudimentary stage, and not until the specific virus is revealed can very definite or dogmatic statements be made concerning its causation. As in other diseases of this group, much may be gained from a careful study of clinical observations, and on this we must rely until more exact methods are forthcoming.

Foremost is the *epidemic* nature of the disease: a more marked feature than in either measles or scarlatina. The observation of Edwards, who cites Liveing, Thomas, and Meigs, coincides with this opinion. In no instance in the writer's experience has a sporadic case of rubella been observed, nor has it ever been limited to a single family, while sporadic cases of measles and scarlatina, or instances of infection limited to a single dwelling, have several times been encountered. This, however, should not be construed to mean that such cases never occur. It is not known what special influences determine epidemics of rubella, further than that they occur, for the most part, in the cool, damp months. From the fact that epidemics frequently appear on the Island of Malta as soon as the rainy season sets in, Walch[616] concluded that the virus might arise spontaneously. While admitting that many epidemics of rubella are mistaken for mild cases of measles, the writer is of opinion that they occur at less frequent intervals than do those of either scarlatina or measles. During the past year an epidemic of measles occurred in Cleveland, during which some of the illustrations for the present work were taken. The epidemic began in March with a few scattered cases and in April and May was at its height. Early in May

[615] Keating: "Trans. Coll. Phys. Phila.," June 7, 1882.
[616] Walch, quoted by Griffith (*loc. cit.*).

the first cases of rubella were seen. These increased slowly at first, but in the course of from four to six weeks the disease multiplied rapidly and the epidemic reached its maximum; while the epidemic of measles had well-nigh disappeared. In this epidemic the contagium, feeble at first, increased in virulence by successive transmissions, and it continued until hot weather set in about the last of June, and no cases were reported after the middle of July. From this it would appear that the virus is subject to cultivation, and varies in activity at different times and under different conditions. This would account for the wide discrepancy of authors concerning its contagiousness.

Its *contagious* property has long since been known, and is duly in accord with common observation. For instance, in an institution containing 100 children, Griffith reports that 37 took the disease in spite of prompt and careful isolation. Of 196 inmates in an asylum, according to Hatfield,[617] 110 were affected.

On the other hand, most authors regard it as less contagious than measles, and some (von Nymann, Klaatsch) speak of it as very feebly contagious, while others (Steiner, Kassowitz) have even doubted its contagious character. So far as the present writer has been able to ascertain, it is at certain times not only as contagious as measles, but the contagium retains its vitality longer after being cast off, and in this respect it corresponds more closely to that of scarlatina. For this reason it is more prone to adhere to clothing or to be carried by fomites.

Its *infectious* property has been especially emphasized by Edwards (*loc. cit.*, p. 687), who estimates that fully 75 per cent. of cases in an epidemic in Philadelphia was traced to infection from the bunks of ships. This would tend to confirm the opinion that the virus is more tenacious of life than is usually observed in measles. It is also supposed that it may be carried by a third person, and may retain its infective property for some time about rooms, dwellings, etc. Little is known as to the stage in which the disease is most readily communicated, but, like other affections of its class, it is probably contagious as soon as the first symptoms appear. Squire[618] believes it may be communicated before the rash appears and for a month thereafter, and Griffith (*loc. cit.*) found that, in spite of prompt segregation as soon as the first symp-

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[617] Hatfield: Chicago Medical Examiner, August, 1881.

[618] Squire (William): "Trans. Internat. Med. Cong." (London, 1881), abstracted in Archives of Derm., New York, July, 1882, p. 221.

toms appeared, the disease continued to spread; which goes to prove that it is contagious as soon as the symptoms become manifest and probably during the prodromal stage. As in measles, we have reason to believe that the contagium is contained in the blood and possibly the secretions of certain mucous membranes, such as the tears, sputum, and nasal discharges when such exist.

Age plays an unimportant part in the etiology of rubella. As in various other infectious diseases which appear at frequent intervals, many children are attacked, thus rendering them immune for the rest of life; many, however, escape, which renders them susceptible later in life. I have been impressed by the number of cases in adults that have presented themselves at my clinic at Lakeside Hospital, showing that the number of susceptible persons in adult life is very considerable. This may be accounted for by the comparative infrequency of epidemics, and the resistance offered by many to infection. Hardaway (*loc. cit.*, p. 583) has observed in a number of instances that the disease when introduced into families attacked only one or two of a large number equally exposed. J. Lewis Smith (*loc. cit.*, p. 305) and Liveing[619] have likewise observed this peculiarity. My experience in regard to the frequency with which adults are attacked with rubella seems to be uncommon. Thomas reports only 3 adults in 77 cases; of 42 cases reported by Emminghaus, 2 were in adults; 19 to 1 is the ratio given by Roth[620]; in 64 cases Kassowitz (*loc. cit.*) noted only 5 adults; and of Griffith's 100 cases, only 1 was in an adult. Infants usually escape, partly on account of their more general protection from exposure, partly because of their partial immunity. This, however, is not without many exceptions, and infants have contracted the disease a few days after birth. Hardaway gives from five to fifteen years as the time of life in which the disease is most prevalent, while Edwards says that most cases occur before the fifth year. Finally, while notes taken by the present writer do not show the disease later than the twenty-ninth year, it may occur in advanced life, as shown by Seitz, who reports rubella in a woman aged seventy-three years (Edwards). Thus, age alone offers no sure barrier to infection, while it must be conceded from the foregoing that rubella is essentially a disease of childhood.

Sex has no influence on the disease.

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[619] Liveing (Robert): London Lancet, March 14, 1874.
[620] Roth, quoted by Edwards (*loc. cit.*).

DIAGNOSIS.

Measles.—As may be seen from the foregoing pages, rubella is most liable to be confounded with measles, and while, in a general way, the two diseases present a marked dissimilarity, yet in cases which depart from the usual type, when isolated, or at the beginning of an epidemic, it is generally admitted that some difficulty in differentiating the two would be encountered. There is no pathognomonic or unvarying guide between these diseases, and the diagnostician must rely solely on the course and general character of the affection. There is no one symptom that may not be counterfeited in the other disease, so that it is unsafe to rely on this or that symptom in arriving at a conclusion. Moreover, it has been shown that the initial period in rubella may be unduly protracted, and that of measles shortened; that the coryza in measles may be insignificant, while it may be pronounced in rubella; that fever may precede the eruption in rubella one or more days, while it may scarcely be detected in the prodromal stage of measles; that in measles it may be impossible to obtain any history of sickness preceding the rash, while in rubella pains in the joints, headache, nausea, and vomiting may be pronounced; and, finally, that the eruption may be faint and indistinct in measles, while bright and well pronounced in rubella.

The enlargement of the superficial lymphatic glands is sometimes pronounced in measles, while it may be imperceptible in rubella; and in many cases the lesions in the mouth and fauces offer no signs that are sufficiently peculiar and invariably distinctive in each disease to be termed pathognomonic. Taken together, however, the symptoms are distinctive, and when a number of cases occur, as in an epidemic, the type, as detailed, will readily become apparent. Added to this the fact that the disease attacks indiscriminately those who have and those who have not previously had measles, the diagnosis may be arrived at with certainty. Of 48 cases reported by J. Lewis Smith, 19 had previously had measles and 1 patient who had rötheln took measles subsequently (*loc. cit.*, p. 303); of 33 cases reported by De Man,[621] 10, or nearly one-third, gave a previous history of measles; of Thierfelder's 45 cases, 22, or about one-half, had had measles; of Shuttleworth's[622] 27 cases, 15 are reported to have had measles; and of 88 cases reported

[621] De Man, quoted by Griffith (*loc. cit.*).
[622] Shuttleworth: Brit. Med. Jour., 1880, ii, p. 49.

by Dukes,[623] fully 61 had had rubeola. The fact that any *individual patient* has had measles should not, however, be taken as proof positive that the present attack must necessarily be rubella, for numerous well authenticated instances are recorded in which measles has occurred a second time. In an epidemic of rubella it must soon appear to the most indifferent or careless observer that prodromal symptoms are absent, or nearly so, in all cases; that coryza, lacrymation, and photophobia are not troublesome; that there is little or no fever throughout the whole course of the disease; that the eruption is light colored instead of dusky and cyanotic, and enlargement of the post-cervical lymphatic gland is well-nigh constant and out of proportion to the mild character of the affection. The fleeting character of the eruption is more pronounced than in measles, and on this account a typical illustration, showing the mature eruption over the whole body as in measles, could not be procured. (See Plate XLI.) While it may be impossible to differentiate in some cases from the eruption alone, yet it serves a useful purpose in the *ensemble*. In this, the color is important, and when simulated, as it often is in mild cases of measles, the remaining symptoms do not correspond to the same degree. For example, a mild attack of measles with a pinkish exanthem usually shows a marked disturbance of the various mucosæ. Again, the size and contour of the lesions should be noted, as they rarely fail to afford some assistance in the diagnosis. The spots in rubella are always smaller than in measles, and, when they do coalesce to form larger *plaques* or extensive areas, the margins and outlying regions retain the small, roundish, ill-defined macules.

Finally, the following distinctive points should be kept in mind:—

First.—That rubella is sometimes feebly contagious, while measles is always violently contagious.

Second.—The prodromal stage is always short and quite insignificant in rubella, while in measles it continues from three to four days.

Third.—In measles the prodromal stage is usually accompanied by marked constitutional symptoms, with catarrh of the upper air-passages, lacrymation, photophobia, and a more or less characteristic eruption in the mouth, which appears from twelve to forty-eight hours before the cutaneous exanthem. In rubella no characteristic pro-

[623] Dukes (Clement): "On the Features which Distinguish Epidemic Roseola (Rose-rash) from Measles and from Scarlet Fever" (London, 1894), and London Lancet, 1881, ii, p. 743.

dromata are observed, and only at the beginning of the eruptive stage is there usually a slight hyperæmia of the conjunctivæ, of the faucial mucous membrane, and rarely of the upper air-passages. On the soft palate and uvula there is sometimes a punctate or faint macular enanthem, which by some is considered distinctive. Even in mild cases of measles the disturbance of the mucous membranes is more severe than in severe cases of rubella, and there is always, so far as I have observed, a bluish or skim-milk tint to the mucous membrane of the mouth, which I have never found in rubella. In rubella sore throat is present in nearly all cases, while in measles sore throat is uncommon.

Fourth.—The eruption in rubella appears most frequently on the first or second day, rarely later. It often disappears from parts first attacked before other regions become involved. It is of a pale-red or pinkish color, very rarely assuming a dusky tint, and the individual spots are surrounded by a faint areola, thus obscuring the outline of the lesion. The spots are papulo-macular, for the most part round or slightly oval in shape, and present no tendency to form crescents or groupings. Sometimes by coalescing they unite to form extensive areas, which, in all cases either at the periphery or on more remote parts, are associated with the discrete, small macules which give character to the eruption. The rash rarely lasts longer than three days, and most frequently it disappears on the upper part of the body on the second; while in measles the eruption almost always appears on the morning of the fourth day, sometimes on the third, and rarely earlier. In measles the color is of a dark or purplish red, and the lesions are well defined, with normal skin intervening. They enlarge at the periphery and show a marked tendency to form groups and crescents. These are especially marked on the face, neck, and upper part of the trunk. In all cases the individual lesions are larger than in rubella and present an irregular or serrated margin. The eruption attains its maximum development more slowly than in rubella; so that the whole surface of the body may be involved at the same time, consequently, it remains longer than that of rubella, lasting from four to five days or longer, when defervescence begins.

Fifth.—In rubella the superficial lymphatic glands of the neck are nearly always involved, being swollen and sometimes painful; while in measles marked or painful enlargement of the glands of the neck is decidedly uncommon.

Sixth.—In rubella the temperature may be only slightly above the normal at any time during the course of the disease, and it rarely

exceeds 102° F. (38.8° C.). Nor is the temperature curve in any way characteristic of the affection. Further, it is usually of short duration and rarely continues beyond the second or third day. In measles fever is always present and the temperature is sometimes high. There is an initial rise of temperature during the prodromal stage, which usually subsides, returning just previous to the appearance of the eruption, and attaining its maximum at the height of the efflorescence. The fever may continue until the seventh or eighth day.

Seventh.—Rubella is seldom accompanied by complications or followed by sequelæ, while in measles complications are common and constitute the most serious feature of the disease.

Scarlet Fever.—Next to measles, rubella is most usually mistaken for mild cases of anomalous scarlatina. This occurs, however, only when the sore throat in rubella is unusually severe, the fever high, and the rash punctate and confluent. It is, indeed, seldom that all of these occur in rubella at the same time; hence, only in very exceptional cases is there danger of confounding the two diseases. There is a striking contrast between the onset of these affections. In rubella it is mild and insidious, while in scarlatina it is ushered in by short though violent prodromata, fever, and sometimes vomiting. The appearance of the throat in some cases, and usually the tongue, may be considered almost pathognomonic in scarlatina, while these symptoms are ill defined or wholly absent in rubella.

The eruption is fiery red, appearing first on the neck or upper part of the trunk in scarlatina, and on the face in rubella. In the latter disease it is evanescent, while in the first named it continues from five to seven days. In scarlatina the rash is made up of minute, brightly injected puncta, slightly elevated and closely studded together, forming a uniform or finely mottled surface, while the rash of rubella is always "measly," and never becomes entirely confluent. In rubella the rash invades the region of the lips, while the skin about the mouth is comparatively free in scarlatina. Finally, scarlatina is not infrequently accompanied by grave constitutional symptoms, such as pharyngo-nasal inflammation, otitis, etc., together with albuminuria and casts, which are almost unknown in rubella. Withal, scarlatina is one of the most virulent diseases of childhood, while rubella is one of the mildest, shortest, and most benign.

Syphilis.—In my clinic it has been observed that most cases of rubella present a somewhat feeble resemblance to the early efflorescence of syphilis, and nearly all are classed by the distributing clerk

under this disease. The mild though wide-spread catarrhal disturbance, however, instead of the more limited faucial congestion of syphilis, together with the color and distribution of the exanthem, are usually sufficient to enable one to readily differentiate between them. The presence or absence of the initial lesion of syphilis would naturally afford valuable information for diagnostic purposes.

Drug eruptions might possibly in some instances be mistaken for rubella, but what has previously been said under measles applies equally to rubella.

PROGNOSIS.

The prognosis of rubella is favorable, although it must be conceded that it varies somewhat in different epidemics, and is further influenced by the previous health and sanitary surroundings of the patient. In the epidemic reported by Edwards, in which small children were admitted to the hospital from the steerage of ships, and after the consequent hardships of a long ocean voyage, it is not strange that the disease assumed such grave complications, and was followed by the almost unprecedented death-rate of 4 $^1/_4$ per cent. Hatfield, however, records a mortality of 9 per cent., under possibly worse sanitary conditions, while Aitken, Patterson, and Copeland, according to Edwards, say that the prognosis should be guarded. Klaatsch quotes Kronenberg to the effect that bronchitis, pneumonia, and cerebral congestion caused four deaths in the cases under his care. On the other hand, there is a consensus of opinion among writers as to the benign course and favorable termination of the disease. As has been pointed out under the head of complications, the strong tendency to or the occurrence of many diseases may be facilitated by an attack of rubella in the same way that a common coryza may be the precursor of phthisis. Under ordinary conditions, however, the prognosis may be considered almost invariably favorable.

TREATMENT.

It is not usually considered necessary to institute very rigid quarantine measures in rubella, although delicate children should not be ruthlessly exposed. In asylums and other unfavorable institutions the same rules apply that were given under the prevention of measles. Von Jürgensen advises that children be kept from school for about five weeks, and that the same precautions be taken that are recom-

mended for measles. This, in my opinion, is uncalled for, as the duration of the disease is short and its contagium easily destroyed.

In patients of average health no treatment whatever is required, except to guard against undue exposure to cold and wet. It is advisable to retain patients having rubella within doors, although it is not necessary, unless catarrhal or other complications arise, to confine them to bed. The diet should be regulated according to their condition, and usually a mild, easily digestible dietary is to be preferred. If complications arise, they should be treated according to the general principles applicable to the affection without special reference to the exanthem. After recovery the apartments should be fumigated and freely aired.

ADDENDUM.

TABLE SHOWING THE CHIEF FEATURES IN INFECTIOUS

	VARIOLA.	VARICELLA.
PERIOD OF INCUBATION.	Twelve days.	Fourteen days.
PRODROMAL SYMPTOMS.	Always present and usually severe, with headache, vomiting, pain in the back, and high fever; duration, three days.	Often not observed at all and never severe, consisting of the ordinary mild febrile symptoms, which seldom continue longer than from a few hours to a day.
TIME THE ERUPTION APPEARS ON THE SKIN.	Appears fairly constantly on morning of fourth day; first seen on forehead and face.	Often the first symptom noticed; usually first appearance on back and chest.
APPEARANCE AND DEVELOPMENT OF THE ERUPTION.	First red and papular, feeling like shot imbedded in the skin: appears in regular order from above downward and entire body involved in from twenty-four to thirty-six hours; on second or third day vesicles form on papules having thick walls, which become opalescent within a day or two and finally yellow; umbilication at some period of development, mature on eighth day of eruption, sooner in varioloid; contents not readily evacuated.	First macular and deep pink, with formation of vesicle in centre within a few hours; develops rapidly to size of split pea and is translucent, with thin walls; fully developed on second day; appears in crops without order on different parts of the body; never indurated and easily evacuated.
ERUPTION ON MUCOUS MEMBRANES.	Throat often reddish; pustules often seen on tongue, pharynx, and inner surface of cheeks, co-existent with exanthem; lips and tongue parched and dry.	Tongue often slightly coated; vesicular enanthem often appears on palate and inner surface of cheeks simultaneously with eruption on skin; usually appears as small, excoriated spots.
CONSTITUTIONAL SYMPTOMS.	Often severe, but depend on extent of the eruption; mild in varioloid; often disappear on appearance of rash.	Slight and usually absent.
FEVER.	Temperature falls on appearance of rash and usually rises when pustules mature about the eighth day; morning remissions common.	Always slight; sometimes detected only when eruption appears and sometimes not at all.
DESQUAMATION.	Pocks desiccate and form dark crusts; usually complete in from fifteen to twenty-four days, leaving scars.	Desiccate, forming superficial crusts; fall off in from seven to fifteen days, often leaving pigmentation and sometimes superficial scars
COMPLICATIONS AND SEQUELÆ.	Furuncles, abscesses, and tuberculosis.	Seldom seen.

THE DIFFERENTIAL DIAGNOSIS OF THE ACUTE EXANTHEMATA.

RUBEOLA.	RUBELLA.	SCARLATINA.
Eleven days.	Fourteen to eighteen days.	Two to five days.
Coryza, dry cough, and watering of the eyes, with photophobia, moderate fever, sometimes vomiting; usually continues three days.	Often absent, always mild: slight sore throat, watering of the eyes, and swelling of post-cervical lymph-glands: one or two days' duration.	Headache, sore throat, high fever, rapid pulse; may have vomiting and severe nervous symptoms; submaxillary glands usually enlarged and tender to touch: duration, twenty-four hours or less.
Morning of fourth day, on face or neck.	Usually first or second day, on face or upper part of trunk.	During first or second day. On neck and upper part of chest.
Macular, blotchy, dark red or slightly violaceous; size of large bean; tends to form clusters: lesions serrated at margin and slightly elevated; disappear in three or four days.	Small, faded rose-colored spots; discrete, not in clusters; may resemble either measles or scarlatina: appear in regular order on the face, trunk, upper and lower extremities; fade on face before legs involved; disappear in two or three days.	Punctate, intensely red, confluent and apparently continuous: "boiled lobster" appearance. It travels downward, invading whole body in from twelve to twenty-four hours: avoids region of mouth and nose; remains three or four days.
Bluish, or "skimmed-milk," tint often seen the first day; characteristic enanthem often seen twenty-four to forty-eight hours before skin eruption; consists of reddish maculæ, with central bluish-white dots, best seen on hard and soft palate and inner surface of cheeks.	Slight macular enanthem comes at first appearance of exanthem and is best seen on soft palate.	Early on second day diffuse mottled reddening first over uvula, hard and soft palate, and inner surface of cheeks; "strawberry tongue": throat continues red and tonsils swollen.
Increase with eruption.	Very mild or absent.	All symptoms increase with development of eruption; pulse rapid and out of proportion to fever.
Increases with development of rash and subsides when eruption matures.	Very little, if any.	Continues high for from three to six days.
Branny, begins on fourth day, and is usually imperceptible.	Scarcely perceptible.	Begins on sixth to eighth day; sometimes in large flakes.
Frequent: broncho-pneumonia, tuberculosis, suppurative inflammation of middle ear, and naso-pharyngeal catarrh.	None.	Albuminuria is almost always present, and renal complications are frequent.

FORMULARY FOR DISINFECTION ESPECIALLY APPLICABLE TO THE EXANTHEMATA.

No. 1. ℞ Mentholi .....gr. iij (0.2000).
Thymoli .....gr. $^1/_{10}$ (0.0065).
Ol. gaultheriæ .....mij (0.0300).
Glycerini .....f3iv (16.0000).
Chlorophyli (sol. aquæ).....q. s.
Aquæ .....q. s. ad f℥viij (240.0000).

M. Sig.: May be used when a mild disinfectant is desirable, as a gargle to the mouth and throat, or diluted in the form of a spray into the nares, larynx, etc.

The vegetable green is used only to give it a distinctive color, as it is advisable to have all poisonous and non-poisonous solutions used in the sick-chamber or hospital ward readily distinguishable. Thus, all gargles, sprays, and innocuous solutions may be TINTED GREEN; external applications of a mild nature YELLOW or WHITE; and all caustic and poisonous solutions RED or PURPLE. Either the tincture of cudbear or the potassium permanganate will serve well as coloring agents to the dangerous class.

No. 2. ℞ Tinct. saponis viridis.....f℥ij (60.0).
Glycerini .....f3ij (7.0).
Formaldehydi .....f3j (3.5).
Aquæ .....q. s. ad f℥iv (120.0).

M. Sig.: Hospital soap. This cleanses more effectually than hard soap, and, as it does not usually injure the epidermis, may be used by delicate-skinned persons.

No. 3. ℞ Hydrarg. bichloridi.....gr. iv (0.26).
Glycerini .....f3vj (21.00).
Ol. myricæ .....gtt. x (0.60).
Essen. lavandulæ .....f3iv (14.00).
Aquæ .....q. s. ad f℥xvj (480.00).

M. Sig.: To be used as a toilet lotion.

If this prove too irritating the following may be substituted:—

No. 4. ℞ Tinct. sapon. viridis.....f3ij (7.0).
Tr. benzoinæ .....f3ij (7.0).
Alcoholis .....f3ij (7.0).
Formaldehydi .....mlxxx (4.7).
Glycerini .....f3iv (14.0).
Aquæ dest. .....q. s. ad f℥xvj (480.0).

M. Sig.: To be used as a toilet lotion for the hands, etc. It may also be employed as a substitute for soap.

No. 5. ℞ Acidi borici .....ʒi-iij (40.0).
Essen. lavandulæ .....f3v (20.0).
Alcoholis .....q. s. ad fʒxvj (480.0).

M. Sig.: To be applied as a lotion. Especially applicable to the face or general surface of the body in variola, measles, scarlatina, varicella, etc.

No. 6. ℞ Calc. chlorinatæ .....ʒxvj (453.6).
Aquæ .....C. iij (2880.0).

M. Sig.: To be employed as a general disinfectant, used freely in privy-vaults, sewers, sink-drains, refuse heaps, stables, and elsewhere, provided the odor is not objectionable. It is one of the cheapest and most effective disinfectants and germicides available for general use. It must be used freely, however, and should come in direct contact by *wetting* everything required to be disinfected. It should be remembered that its *odor* does not disinfect, but only neutralizes or covers up other odors.

This solution, being inexpensive, may be used with great freedom. A quart or more may be used each day in an offensive vault, and in proportionate quantities in other places. In the sick-room it may be used, when its odor does not prove offensive, in vessels, cuspidors, etc. Sheets and other clothing used by the patient may be immersed in a pail or tub of this solution, diluted (1 gallon of the solution to 10 of water) for two hours, or until ready for the wash-room or laundry. It is not poisonous nor does it injure white clothing.

It may also be used for washing the hands or other parts of the body when exposed to infection from excreta, etc. When used on the hands it is advisable to anoint the skin immediately afterward with vaselin, or, better, Formula No. 10, to prevent undue irritation and chapping. In preparing it care should be taken to obtain *fresh* chloride of lime.

An odorless substitute for the above may be prepared by sprinkling 1 quart (960 cubic centimetres) of water gradually upon a quart of quick-lime broken in small pieces in a metallic or wooden vessel. When the lime is reduced to a powder 3 quarts (2880 cubic centimetres) of water should be added and the whole kept in a covered vessel and labeled *milk of lime.*

No. 7. ℞ Hydrarg. bichloridi,
Pot. permanganatis .....aa ʒj (30.0).
Aquæ .....C. viij (7680.0).

M. Sig.: Use as a general disinfectant. It is poisonous, but its bright-purple color will prevent its being mistaken for any other solution. It corrodes metallic substances; otherwise it may be used in the same way and for the same purposes as No. 6. It has no odor; hence its use is more agreeable in vessels, cuspidors, and in the sick-chamber, while the chloride of lime is better for vaults, sewers, drains, etc.

No. 8. ℞ Hydrarg. bichloridi .....3j (4.0).
Aquæ .....C. j (960.0).

M. Sig.: May be used after a case of infectious or contagious disease, to wash the floor, bedstead, chairs, and other furniture.

The walls and ceiling, if plastered, may be whitewashed with lime containing the same proportion of corrosive sublimate as the preceding, or they may be brushed over with the aqueous solution. Special care must be taken to wash all the dust from window-ledges, corners, and other places where it may have settled, and to thoroughly cleanse crevices and out-of-the-way places. After the application of the disinfecting solution, the windows and doors should be widely opened for twenty-four hours or longer to insure free ventilation, after which the floors and wood-work should be well scrubbed with soap and water. This should be followed by a second, more prolonged exposure to fresh air, admitted through open doors and windows.

A solution of carbolic acid (1 part of the pure acid to 20 parts of water) may be employed in place of the bichloride solution. This is also a good general disinfectant for use in the sick-room when its odor is not objectionable.

No. 9. ℞ Zinci sulphat. .....ʒiv (120.0).
Sod. chloridi .....ʒij (60.0).
Aquæ .....C. j (11520.0).

M. Sig.: To be used as a disinfectant lotion for clothing, dead bodies, etc.

No. 10. ℞ Ol. olivæ .....f3ij (8.0).
Lanolini,
Vaselini.....aa q. s. ad ʒij (120.0).

M. Sig.: Used to protect the hands, to soften the skin after disinfection, as an unguent, or as a vehicle for antiseptic substances such as boric acid, mercury, etc.

Disinfection of the Person.

The surface of the body of a sick person, or of his attendants, when soiled with infectious discharges, should at once be cleansed with a suitable disinfectant agent. For this purpose either No. 3 or 6 may be used. In diseases like small-pox and scarlet fever, in which the infectious agent is given off from the entire surface of the body, occasional ablutions with the former, or the latter solution, diluted with 10 parts of water, will be more suitable than carbolic acid or formaldehyde, although the scalp and beard of attendants and physicians should be sprayed with a 2- to 5-per-cent. solution of the last named drug.

This must be done in the open air, care being taken that the eyes are protected.

In all infectious diseases after death the surface of the body should be thoroughly washed with one of the solutions above recommended (preferably No. 8 or 9), and then enveloped in a sheet saturated with the same, and immediately placed in a metallic or air-tight casket. Interment should take place as soon as possible.

Disinfection of Clothing.

Of the greatest importance in coming in contact with infectious diseases is the proper disinfection of the clothing. This has been treated of at length under variola, but it should not be neglected in less virulent affections. Medical men should ever be on guard against being the carriers of disease. The formaldehyde spray (5 to 15 per cent.) is the best disinfectant for this purpose, and, when this is supplemented by an hour or two in the open air, no danger need be feared. For the ward or sick-room it should be remembered that boiling for half an hour will destroy the vitality of all known disease-germs. As a general disinfectant for all washable fabrics there is no better method than the ordinary laundry affords. Care should be taken, however, that articles thus treated are sufficiently boiled, and that no delay or exposure is allowed between the time of removal from the person or bed of the patient and their immersion in boiling water, or the dilute solution given under Nos. 6 and 9. To obviate all danger it is highly desirable in all, and in some cases imperative, that clothing be not permitted to leave the infected room until so treated. In hospitals soiled clothing may be collected in rubber bags which are tied tightly and sprayed with formaldehyde before leaving the room. This method, however, cannot be recommended for general use.

Fumigation.

Three methods of room or ward disinfection have been recommended in the text: fumigation by sulphur-dioxide gas, by formaldehyde-gas, and by heat in the form of steam. Each is efficient when properly done. The destructive effect of *burning sulphur-fumes* on most contagia has long since been known and sufficiently confirmed by general observation. Certain precautions are necessary, however, and the ordinary method, employed by the author for many years, may be given as follows:—

Fumigation with Sulphur.—The infected room or dwelling must be *vacated*, and all articles that cannot be treated by the solutions mentioned should be exposed as freely as possible to the sulphur-fumes. Boxes should be opened, all pockets turned inside out, and *all surfaces exposed* both inside and out. Thus, heavy woolen clothing, silks, furs, stuffed bed-covers, pillows, and mattresses should be hung in the room during disinfection. In case of small-pox, or when discharges have penetrated upholstering, bed-ticks, pillows, etc., they should be ripped open and their contents spread out so as to be acted on by the sulphur-fumes. The room or dwelling should then be closed as tightly as possible, but cracks and corners should be fully exposed to the action of the disinfectant. Three pounds of sulphur (brimstone sticks or flower of sulphur preferred) to a room ten feet square (1360.77 grammes—305 centimetres). It is placed on an iron pan or broad shovel, which is supported upon bricks, and set on fire by live coals or with the aid of a tablespoonful of alcohol is lighted by a match. To obviate the danger of fire, the iron pot or pan in which the sulphur is burned should be placed over water in a tub or pan. Care should be taken not to inhale the fumes, and, as soon as it begins to burn well, to leave the room and close the door. It should be seen to that all the sulphur is consumed, and that the room is kept closed for several hours—from three to six—according to the virus to be acted upon. After this it should be opened as freely as possible and currents of air and sunlight allowed free access for a whole day. All articles in the room should then be hung in the open air, beaten, and shaken. Carpets are best fumigated on the floor, but should afterward be removed to the open air and thoroughly beaten. In no case of dangerous disease should this disinfection of the room, clothing, bedding, etc., be omitted.

Disinfection by Formaldehyde.—Formaldehyde is now generally considered to be superior in every respect to sulphur for the disinfection of rooms and their contents, if used with care and exactness. Our extensive use of formaldehyde as a disinfectant during the past three years, both at the Cleveland Small-pox Hospital and at Lakeside Hospital, has demonstrated its value as a surface disinfectant and its superiority in many ways over the older methods. The main objection to its employment arises from the fact that it is only a *surface disinfectant*. To overcome this objection the following method, employed at Lakeside Hospital, may be recommended: An air-tight chamber of sufficient dimensions is provided with an exhaust apparatus so that a

partial vacuum (eight atmospheres or eight pounds to the square inch) may be obtained. Clothing, mattresses, pillows, blankets, etc., are placed in this chamber, the air exhausted, and formaldehyde (5 ounces of the 40-per-cent. solution to every 1000 cubic feet of space) is introduced. This is continued for four or more hours. At the Lakeside Hospital it is customary to allow articles to remain in the disinfecting chamber twenty-four hours. (In the absence of special apparatus formaldehyde-gas may be made for the purpose of disinfection by lighting a large alcohol-lamp and supporting a thin sheet of iron or small tin dish over and in contact with the flame. It is important to remember that methylated spirits or wood-alcohol is essential.)

By this method the disinfectant is forced deeply into and permeates the interior of pillows and mattresses and other articles in a way that has proved highly efficient. Experiments made in the pathological laboratory have demonstrated that the ordinary bacteria are killed when placed in the centre of a mattress or pillow thus treated. When proper appliances are not at hand for an exhaust-chamber, the measures recommended under variola, or those generally given out by boards of health, may be adopted, as the following, used by the State Board of Health of New Hampshire:—

The room to be disinfected is sealed and prepared as for sulphur disinfection. All surfaces are exposed as freely as possible; closet doors are opened and their contents, together with the contents of boxes, drawers, etc., are removed and spread about, the drawers and boxes to be left open; mattresses are placed on end, pillows, bedding, clothing, etc., are suspended from lines stretched across the room or spread out on chairs or other objects so as to afford the fullest exposure, and books are opened and the leaves separated. In short, the room and its contents are so arranged as to secure free access of the gas to all parts. On this depends the thoroughness and consequent value of the disinfection.

An ordinary bed-sheet (2 x 2 $^1/_2$ yards, or 2 x 2.5 metres) is then suspended by one edge from a line stretched across the middle of the room. Properly sprinkled, this will carry without dripping 5 ounces (150 cubic centimetres) of formalin,—the 40-per-cent. solution of formaldehyde,—which is sufficient to disinfect 1000 cubic feet (305 metres) of space, or a room 10 feet (3 metres) square. As many sheets as necessary are used, hung at equal distances apart. The ordinary, coarse, cotton sheet is to be preferred, as it facilitates more rapid evaporation.

The sprinkling is done by means of a spray-producer, as it is

found that the freest evolution of the gas with the minimum production of paraform is secured from very minute drops of the solution, individually scattered; that is, not touching or running together, on the evaporating surface.

When all is in readiness the disinfector ties a damp towel or sponge over his mouth and nose, and, beginning with the sheet farthest from the door of exit, rapidly sprinkles each sheet on his way out, being careful to spray evenly and no space more than once.

The evolution of the gas is so rapid that the air becomes irrespirable in about three minutes, so that quick action is necessary. It has also been found necessary to provide the operators with surgeon's rubber gloves to protect the hands and wrists from the spray.

The room is left closed not more than five hours, after which it is opened up as freely as possible to sunlight and air; the family is instructed to have all wood-work well scrubbed with soap and hot water or with the mercuric-chloride solution, and the furniture and other objects thoroughly wiped with cloths moistened with dilute formalin (1 part of formalin to 20 parts of water).

Disinfection by Heat. — The experiments of Koch, Gaffky, and Loeffler have demonstrated that baeteria are killed by a temperature of 320° F. (160° C.). Later, Esmarch and Dunker demonstrated that when moisture was added a temperature of from 212° to 248° F. (100° to 120° C.) was found sufficient. Heat in the form of steam is therefore used in disinfection. A chamber, as for formaldehyde-gas, is provided, and, after placing the articles to be disinfected therein, the air is exhausted until a vacuum of from fifteen to twenty atmospheres is produced, when the steam is allowed to enter. In this way permeation throughout mattresses, pillows, and quilts is assured. A strong objection to disinfection by heat arises from the fact that it injures the fabric of many articles, and when moist heat or steam is employed it renders the interior of pillows and mattresses damp. Furthermore it has been found frequently to interfere with the dye of cloth, hair, wool, etc.; hence it is less serviceable than the preceding methods of disinfection.

Care of Rooms in Private Dwellings during the Presence of an Infectious Disease.—In addition to what has been said, it is highly important to impress on the minds of those having charge of the sick-chamber that the special poison of the disease is constantly given off from the patient, and that to allow it to accumulate within a close room renders its infective property especially active and thus aug-

ments its danger to others. So far, therefore, as is consistent with the welfare of the patient, the room throughout the whole course of the illness should be constantly ventilated and frequently aired. It is well to provide a means of disinfecting the foul air as it leaves the room, by keeping a fire burning night and day in an open fire-place. Where this is not provided an open stove will serve the same purpose. It is likewise well to keep in the sick-room a vessel containing the zinc solution previously mentioned, for the reception of towels, sheets, and other articles of clothing which are not to be burned or disinfected in a specially prepared oven.

Hospitals and Wards for Infectious Diseases.—As a means of preventing the spread of infectious diseases, the law authorizes the inhabitants of cities, villages, and townships in most States to be constantly provided with hospitals for the reception of persons having small-pox, scarlet fever, measles, or any other disease dangerous to the public health. In case no provision has been made previous to an outbreak of any such disease, the law directs local boards of health to provide proper hospitals or places of reception for the sick and infected as in their judgment seems best for the accommodation of the afflicted and the safety of the inhabitants. It is further incumbent on the local health authorities, as provided by law, to cause all persons infected, or supposed to be infected with any of the diseases previously mentioned, to be, without delay (provided their condition will admit), conveyed to such hospitals or places of reception.

Hospital Construction.—Since the erection of hospitals is sometimes utilized for ulterior or selfish ends, rather than the proper care of the sick, it seems incumbent at this time that a few essential features of a general nature be mentioned. This unfortunate condition applies more especially to hospitals which fall under the moral plague of American cities commonly denominated "politics." It was formerly thought that hospitals for contagious diseases should be placed in some out-of-the-way place, remote from dwellings. This opinion still prevails among the laity, and strong opposition is always made by those living in the vicinity of a proposed hospital site. Careful observations have been made, however, which tend to dispel the ground-work of this popular belief. In the Boston City Hospital (*loc. cit.*, p. 7) it has been found that no cases of scarlet fever developed within the one-eighth-of-a-mile circle, and fewer cases occurred within the quarter-mile circle than between the three-fourths and the mile circles, respectively (see page 230). Our

experience in Cleveland goes to prove that, when *properly conducted*, no danger may be feared from a hospital or ward which is *completely shut off* from surrounding buildings. To insure this safety to the territory immediately surrounding the hospital, strict quarantine must be maintained, and nurses, orderlies, and resident physicians must not be allowed to come in contact with anyone outside the hospital grounds. It has been repeatedly demonstrated that air and the sun's rays are potent germ-destroyers, but that various contagia adhere to articles such as clothing, the hair, dishes and refuse from the table, etc., and, to maintain an efficient quarantine, these should not be allowed to leave the infected area until after disinfection. Therefore a disinfecting appliance and a crematory for disposing of garbage are among the prerequisites of a hospital for infectious diseases. Both of these should be near at hand to obviate the necessity of spreading the infected area. The more simple in construction the better. A trap-door should connect directly with the disinfecting rooms and furnace; this is better than carrying articles from one room to another, or connection by shafts or dumb-waiters. During an epidemic or in the country these may be extemporized.

Sunlight, ventilation, and heating must next be considered. The importance of allowing free ingress of the sun's rays when desirable cannot be overestimated, as it is known to be the most efficient disinfectant. It is also desirable to allow the light to enter from all sides of the room if possible.

Ample provision for ventilation should be made. When other buildings or wards are in close proximity to the infected ward, ventilation through open windows and doors should be strictly guarded against. For this reason it is better to have them constructed so that they cannot be opened in the ordinary way. The fresh air should pass over heated coil pipes before entering the room, which should take place at different elevations to insure a freer admixture than when the current is established in one direction only. Thus, when two flues are sufficient, as in a small room, one should enter within two feet from the floor, and the other about two-thirds of the wall space upward. The aperture for the exit of foul air should be placed near the floor. The foul-air shaft should extend without angles or other obstruction upward, and open above the roof.

When stoves are used to heat the room they should be "jacketed," —that is, surrounded by a sheet-iron jacket; and the inlet of fresh air should be conducted from without so that it strikes the back of the

stove inside the iron sheeting. The foul air may escape either through an open grate in which fire is constantly kept or in a flue as previously described.

Ample facilities for bathing should also be provided. The bath-room should be constructed so that it may be easily cleaned by means of a hose or other flushing. The floor and walls are best made of cement, and in all such rooms there should be an outside window. Portable bath-tubs should be at hand for patients too ill to go to the bath-room.

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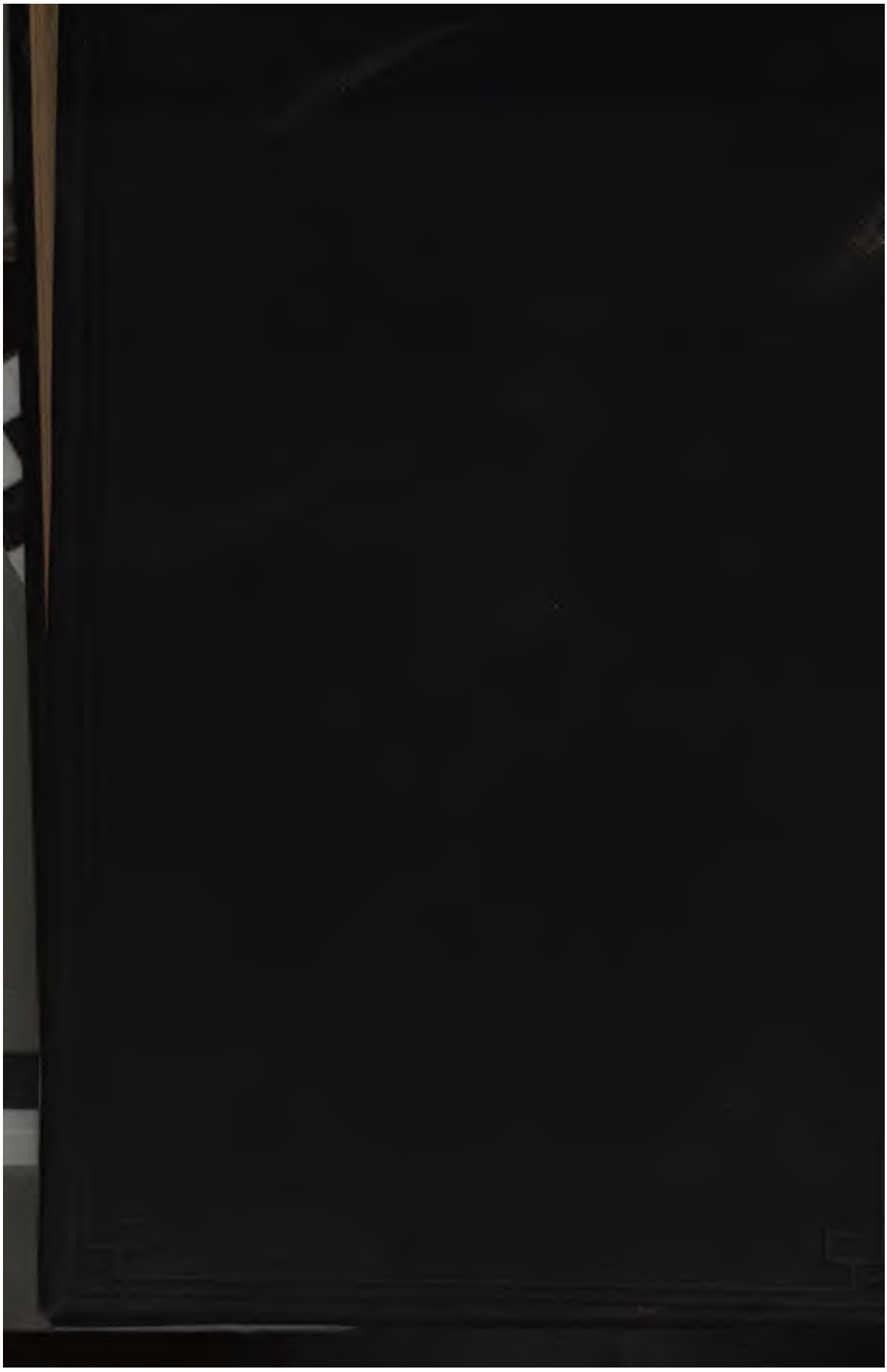
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